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Original articles—

ORIGINAL ARTICLES

STUDIES IN BUNDELKHAND SOILS OF THE UNITED PROVINCES

II. CHEMICAL COMPOSITION OF THE CLAY FRACTIONS IN RELATION TO THE PROCESS OF SOIL FORMATION

By R. R. Agarwal, M.Sc., D.Phil., Agricultural Chemist to Government, United Provinces, Cawnpore, and P. Mukerji, B.Sc. (Ag.), Assoc. I.A.R.I., Senior Research Assistant

(Received for publication on 4 September 1944)

In a previous communication Mukerji and Agarwal [1943] reported the results of their investigations on the soil survey of a typical tract of land in the Bundelkhand region of the United Provinces. In that paper three genetic soil types were recognized and chemical, physico-chemical and mechanical data for each type were recorded along with the morphological characters. These soil types resemble somewhat, although superficially, the associated red and black soils described by Raychaudhuri and associates [1941 ; 1943] from other parts of India. It was, however, suggested, as a result of the discussion of the available data, that the soils of the Bundelkhand region might be classified under the great group of 'immature tropical tschernozems'. In the present paper the separated clay fractions from the profile samples of each soil type have been subjected to a thorough chemical analysis and the results obtained have furnished some very interesting data that throw considerable light on the chief pedogenic factors which are responsible for the formation of soils in that locality.

Literature

During recent years much attention has been paid to a study of the composition of the clay fraction, since it has been recognized that this is of considerable aid in characterizing soils in relation to their development. A large volume of published literature on the subject already exists mainly as a result of work done in Europe and America. Work in India on the pedological aspects of the clay composition of the different soil types has so far been extremely meagre. Reference may, however, be made to the work of Raychaudhuri and associates [1941 ; 1943] on red and lateritic soils of India, in which some investigations have been directed on the composition of the clay complex with a view to discover the nature of the processes of soil-formation leading to those typical soil types. Sen and collaborators [1941] studied certain physical properties as related to the clay composition and their silica-sesquioxide ratios for a number of red and lateritic soils of India.

Experimental

(i) *Methods of analysis*

After washing the soils free from carbonates and sulphates the clay fractions (below 0·002 mm.) were separated from the coarse sand free soils as in the ordinary International Pipette method using very dilute ammonia to assist dispersion according to the sedimentation procedure described by Nagelschmidt [1944]. The clay suspensions were siphoned off and flocculated by adding 5 c.c. of N-calcium chloride. The calcium saturated clay was then carefully washed through repeated decantations and finally collected, dried and preserved for subsequent analysis.

The clay was fused with sodium carbonate in a platinum dish and analysed as a silicate for the more important constituents, except calcium, using ordinary methods. Free silica was determined according to the tri-acid digestion method of Hardy and Follet-Smith [1931]. Free iron oxide was estimated by the modification of Truog's method [1936] as suggested by Drosdoff [1941]. Hardy's alizarin adsorption method to determine the free alumina content was employed as subsequently modified by Hardy and Rodrigues [1938].

There has been some controversy in regard to the results obtained for free alumina in soil colloids through the use of the alizarin adsorption method. However, recently the method of Hardy and Rodrigues has been tested and found to give values of free alumina in soil colloids which were in close agreement with those obtained by the modified method of Truog [1936]; Sulaiman and Mukerji [1941]; Raychaudhuri, Sulaiman and Bhuiyan, [1943] and by the differential thermal method [Alexandar, Hendricks and Faust, [1941].

Base exchange capacity was determined by leaching with N-ammonium acetate solution and estimating the absorbed ammonia in the usual manner.

(ii) *Profile descriptions*

Morphological descriptions of the three soil profiles are recorded in Table I.

TABLE I

The profile descriptions of the soils used in the investigation

Horizon	Depth	Description
		Type 1
A	0—5 in. . . .	Bright reddish brown coarse-grained soil; loosely packed; very light textured; sparse growth of roots; non-calcareous and neutral in reaction.
B_1	5 in.—1 ft. 9 in. . .	Dark brown coarse-grained soil; slightly compact; loamy in texture; sparse growth of roots; non-calcareous and neutral in reaction.
B_2	1 ft. 9 in.—3 ft. 2 in. .	Dark brown soil mixed with big sized whitish stones imparting a whitish grey colour to the soil layer; non-calcareous and neutral in reaction.
C	3 ft. 2 in.—4 ft. . .	Undecomposed parent material loosely held; some whitish rock fragments which are very thinly distributed are calcareous.
		Type 2
A	0—10 in.	Yellowish brown soil; sandy-loam in texture; gritty in feel; single grained structure; friable and loosely packed; non-calcareous and neutral in reaction.
B_1	10 in.—2 ft. 3 in. . .	Brown soil with a faint reddish tinge; sandy-loam in texture; columnar in structure; roots visible; hard and compact towards the bottom; non-calcareous and neutral in reaction.
B_2	2 ft. 3 in.—3 ft. 9 in. .	Same as above but harder and loamy.
C	3 ft. 9 in.—4 ft. 10 in. .	Brownish grey soil interspersed throughout with *kankars* (dolomite); clayey loam in texture; highly calcareous; alkaline in reaction.
		Type 3
A_1	0—1 ft. 5 in. . .	Black clay with a bluish tinge; cracks on wetting; very sticky in feel; impervious and indurated; non-calcareous and neutral in reaction.
A_2	1 ft. 5 in.—3 ft. . .	Same as above but contains whitish fragments of stones loosely held.
B_1	3 ft.—4 ft.	Brownish black hard clay; very sticky and cemented; slightly calcareous and alkaline in reaction.
B_2	4 ft.—5 ft. . . .	Greyish brown hard clay; more calcareous.
C	5 ft.—5 ft. 10 in. . .	Compact ash coloured *bajri* (gravelly calcareous sand) highly calcareous and alkaline in reaction.

(iii) *Analytical data*

(*a*) *Type 1.* The results of analysis of the clay fractions separated from the soils of Type 1 profile mentioned above are tabulated in Table II.

Table II

Results of chemical analysis of clays (Type 1)

Horizon	Depth	SiO_2			Al_2O_3			Fe_2O_3			MgO	K_2O	Loss of moisture above 105°	Ex. cap.
		Total	Free	Comb	Total	Free	Comb	Total	Free	Comb				
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	m.e. Per cent
A	0-5 in.	40·80	3·10	37·70	20·76	0·71	20·05	16·48	9·40	7·08	4·16	1·80	15·50	69·5
B_1	5in.—1 ft. 9 in.	40·70	3·92	36·78	19·26	0·52	18·74	17·68	9·60	8·08	4·73	2·48	14·65	68·0
B_2	1 ft. 9 in.—3 ft. 2 in.	42·97	3·65	39·32	20·96	1·23	19·73	12·98	5·70	7·28	5·69	0·95	15·85	75·5
C	3 ft. 2 in.—4 ft.	41·94	4·33	37·61	17·46	0·96	16·50	13·80	5·90	7·90	6·39	1·78	17·13	81·5

An examination of the data presented in Table II reveals clearly some of the more important developmental and weathering processes undergone in the soils belonging to Type I. Silica shows signs of disruption from the complex as weathering proceeds since it is less in the A and B_1 horizons as compared to B_2 or C horizons. Free silica is present to an extent of about 8-10 per cent of the total silica and it shows a tendency of leaching. The clay in A horizon contains the maximum amount of combined alumina and its content decreases with depth. Alumina shows a trend to be constant in the first three layers but becomes less in the C horizon, showing thereby that weathering tends to increase the alumina content of the clay complex. Iron oxide content is fairly high in the top layers and the free iron oxide is also similarly high in A and B_1 horizons. This probably confers on the soil its characteristic red colour. The accumulation of sesquioxides, both iron and alumina, in top layers and the increase of silica with the depth of the profile show the tendency for laterisation.

The clay of the C horizon seems to be rich in magnesia showing origin from ferro-magnesian minerals. It appears that weathering tends to deplete the clay complex of its magnesia for there is a gradual enrichment of the complex in magnesia as we go down in the profile. The complex is also rich in potash. Exchange capacity increases with depth which may be suggestive of the fact that the clay in the top layers being more sesquioxidic in character has lower exchange properties.

Derived data in regard to molecular ratios of some of the more important ingredients which are present in the silicate complex in a combined form are presented in Table III.

Table III

Derived data for clays (Type 1)

Horizons	Depth	SiO_2 / R_2O_3	SiO_2 / Al_2O_3	SiO_2 / Fe_2O_3	Al_2O_3 / Fe_2O_3	SiO_2 / $RO+R_2O$	SiO_2 / H_2O
A	0—5 in.	2·604	3·19	14·16	4·44	5·13	0·73
B_1	5 in.—1 ft. 9 in.	2·614	3·33	12·11	3·63	4·27	0·75
B_2	1 ft. 9 in.—3 ft. 2 in.	2·736	3·38	14·37	4·25	4·33	0·74
C	3 ft. 2 in.—4 ft.	2·995	3·87	12·66	3·27	3·53	0·66

The ratios of silica-alumina are not constant in all the depths but increase in the bottom layers showing that weathering tends to deplete the soil more of its silica than alumina. The silica-iron oxide ratios, on the other hand, indicate that more of iron is removed than silica but that the distribution fluctuates in alternate layers. The silica-sesquioxide ratios are remarkably constant in

the first two layers but the clay in C horizon has a slightly higher ratio. Silica total base ratios decrease more or less uniformly in the three horizons signifying that the potash and magnesian silicates are subjected to the greatest amount of disruption. Silica/water ratio is constant in A and B horizons but is slightly less in C horizon.

(*b*) *Type 2.* Table IV contains the results of analysis of the clay fractions isolated from the soils of Type 2 profile.

TABLE IV

Results of chemical analysis of clays (Type 2)

Horizon	Depth	SiO_2			Al_2O_3			Fe_2O_3			MgO	K_2O	Loss of moisture above 105°	Ex. cap.
		Total	Free	Comb	Total	Free	Comb	Total	Free	Comb				
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	m.e. Per cent
A	0—10 in.	41·75	3·76	37·99	27·35	5·33	22·02	7·00	5·50	1·50	2·58	1·91	16·30	76·0
B_1	10 in.—2 ft. 3 in.	40·35	4·05	36·30	28·70	8·80	19·90	9·60	6·00	3·60	3·26	1·23	13·80	63·0
B_2	2 ft. 3 in.—3 ft. 9 in.	41·25	5·55	35·70	27·12	7·48	19·64	8·00	7·70	0·30	3·30	1·58	15·30	68·0
C	3 ft. 9 in.—4 ft. 10 in.	40·98	4·50	36·48	21·28	0·77	20·51	11·60	7·40	4·20	4·27	0·78	17·00	67·0

In Type 2 the distribution of total silica is more or less uniform in all the layers but the content of free silica increases with depth. It seems that the free silica obtained from soil decomposition is washed down the profile as in the case of Type 1 profile. The combined silica content is more in the A horizon, and then decreases. The clays in A and B horizons contain more total alumina than the clay in C horizon. But there is greater amount of free alumina in this type than what was encountered in Type 1. The combined iron oxide in the silicate complex is remarkably low and the major portion of the iron oxide exists in the clay in an uncombined state suggesting that the iron silicates are the weakest minerals in the clays. The magnesia and potash contents of the clay seem to indicate the same trends as those found in Type 1 profile. The exchange capacity is highest in A horizon, becomes less in B_1 but increases again in B_2 and C horizons. It seems, as was observed in the case of Type 1 profile, that the exchange capacity of the clay follows to some extent the same order as the combined silica content.

Table V contains the derived data in regard to the molecular ratios of the more important chemical constituents so far as the quantities which exist in a combined form are concerned.

TABLE V

Derived data for clays (Type 2)

Horizon	Depth	SiO_2 / R_2O_3	SiO_2 / Al_2O_3	SiO_2 / Fe_2O_3	Al_2O_3 / Fe_2O_3	SiO_2 / $RO+R_2O$	SiO_2 / H_2O
A	0—10 in.	2·803	2·925	67·28	23·00	7·501	0·70
B_1	10 in.—2 ft. 3 in.	2·773	3·093	26·79	8·66	6·433	0·79
B_2	2 ft. 3 in.—3 ft. 9 in.	3·053	3·083	31·62	10·26	6·023	0·69
C	3 ft. 9 in.—4 ft. 10 in.	2·668	3·016	23·09	7·65	5·315	0·64

The silica-alumina ratios are essentially constant in all the four layers. It is apparent that the accumulation of alumina in top layers observed in Table IV may be only relative. Silica-iron oxide ratios exhibit a very wide variation and show very marked decrease in the lower layers, showing that the soil forming processes are responsible for a considerable disruption of the ferruginous silicates in the soil complex. Silica total base ratios also show a similar breaking down of the silicates rich in potash and magnesia. With the exception of the B_1 horizon, the silica/water ratios are constant.

It is apparent that the processes leading to the formation of soil complex represented by Type 1 in which slight lateritic tendencies were observed have been somewhat stabilized in the formation of the complex represented by Type 2.

(*c*) *Type 3.* In Table VI is given the chemical analysis of the clays separated from the soils of the profile representative of Type 3.

TABLE VI

Chemical analysis of the clays (Type 3)

Horizon	Depth	SiO_2			Al_2O_3			Fe_2O_3			MgO	K_2O	Loss of moisture above 105°	Ex. cap.
		Total	Free	Comb	Total	Free	Comb	Total	Free	Comb				
		Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	m.e. Per cent
A_1	0—1 ft. 5 in. .	45·88	1·70	44·18	24·93	0·47	24·46	7·20	6·10	1·11	2·54	1·45	16·72	79·0
A_2	1 ft. 5 in.—3 ft. .	46·10	1·55	44·55	27·30	0·40	26·90	5·20	4·90	0·30	2·59	1·72	15·69	84·0
B_1	3 ft.—4 ft. . .	44·98	1·10	43·88	26·90	0·50	26·40	5·60	4·40	1·20	3·44	1·28	16·80	79·0
B_2	4 ft.—5 ft. . .	43·55	1·10	42·45	27·50	0·50	27·00	4·80	3·30	1·50	3·49	1·06	17·98	80·0
C	5 ft.—5 ft. 10 in.	42·50	1·10	41·40	26·70	0·31	26·39	3·40	3·30	0·10	3·08	1·03	21·29	68·0

Total silica is more in the two layers of the A horizon and the two layers of the B horizon are similarly more silicious than the C horizon. The distribution of silica shows that, unlike Type 1, weathering does not deplete the complex of its silica but makes it slightly richer in this ingredient. The amount of free silica in the profile is the least of that present in all the three types considered together and so is the quantity of free alumina. Moreover, free silica shows signs of accumulation in the top layers and free alumina is more in A and B horizons as compared to C. It appears that, as a result of the restricted drainage and lower topography of the soil type in question, the rising silica-rich ground-waters resilicate the complex liberated during the soil decomposition.

Combined alumina content is fairly constant in the profile. Free iron oxide as percentage of the total iron oxide has been found to be maximum in this profile. Magnesia and potash show almost similar trends as in the other two profiles. With the exception of A_2 layer the clay of which gave slightly higher exchange capacity the exchange capacity in A and B horizons is more or less uniform but is less in the C horizon. C horizon is again poor in silica content and the base exchange capacity, thus, seems to follow the order of the silica content of the clay.

Table VII shows the derived data for the molecular ratios of the more important ingredients of the clays.

TABLE VII

Derived data for clays (Type 3)

Horizon	Depth	SiO_2 / R_2O_3	SiO_2 / Al_2O_3	SiO_2 / Fe_2O_3	Al_2O_3 / Fe_2O_3	SiO_2 / $RO+R_2O$	SiO_2 / H_2O
A_1	0—1 ft. 5 in. . .	2·979	3·063	106·7	34·54	9·378	0·79
A_2	1 ft. 5 in.—3 ft. . .	2·789	2·805	394·5	140·60	8·984	0·85
B_1	3 ft.—4 ft. . . .	2·739	2·819	97·16	34·47	7·382	0·78
B_2	4 ft.—5 ft. . . .	2·574	2·667	75·19	28·21	7·221	0·71
C_1	5 ft.—5 ft. 10 in. . .	2·655	2·661	..	..	7·889	0·58

Silica-sesquioxide and silica-alumina ratios show that the soil-forming processes have brought about, on the whole, an increase in these ratios. Thus the clay from the C horizon is much less silicious than the clays from either B or A horizons. Silica-iron oxide ratios show that the soil complex is a much weathered material and similar evidence is obtained on a consideration of the silica total base ratios. Silica-iron oxide ratios further give an indication of relative accumulation of iron oxide in the B horizon.

Altogether, it seems indubitable that the soils represented by the profile described above are the highly weathered soils of the locality, as far as the iron oxide and total bases in the clay complex are concerned. However, the type is influenced locally by different hydrographical conditions as a result of lower topography and this brings about slight modifications in the soil-forming processes, specially in regard to the behaviour of silica which gets presumably fixed in the top layers.

DISCUSSION

The chemical analyses of the fractionated clays from the soils of Bundelkhand clearly show that the minerals to be attacked most by the process of weathering are those containing iron and magnesium. In Type 1 soils, which has a very coarse-grained texture and consequently free drainage, magnesia on decomposition is probably lost out of the solum but iron accumulates in the top layers presumably due to its lower solubility and immature character of the soil profile. In Type 2 soils magnesia is not entirely lost but is found along with lime deposited in the C horizon as *kankar* nodules in the form of dolomite ; but free iron oxide shows a tendency of slight eluviation to bottom layers. When the clays of Type 3 are taken into account we find that due to poor drainage magnesia had had no chance of deposition in the form of nodules but is found distributed in the C horizon as small sized *bajri* particles. Free iron in this case, too, is found accumulated in the top layers possibly as a result of precipitation due to the alkaline nature of the soil and restricted drainage conditions. It seems beyond doubt that the translocation of the products of weathering in the soil profile is influenced almost wholly by the topographical conditions of these profiles. Magnesia precipitates in the profile at various points depending on the movements of ground waters ; whereas, iron shows curiously enough three degrees of translocation in the three profiles from accumulation in top layers in the Type 1 soils to leaching in bottom layers in Type 2 and further accumulation in top layers in Type 3.

The three profiles described in the paper represent three successive stages in the development of the soils in the Bundelkhand region and it may be highly interesting to study in what manner the different ingredients in the soil complex are affected by this development. It is expected that such study would throw considerable light on the relative pedogenic forces which are responsible for the gradual alteration of the chemical nature of the soil complex as the weathering progresses. In such a study the horizons of the three successive genetic groups of soils have been arranged in a reverse order. For in all types the C horizon is the least weathered and A horizon the most weathered. Although, it may not be perfectly justified in the absence of relevant data to consider the C horizon of Type 2 as more weathered than the A horizon of Type 1 or the C horizon of Type 3 as more weathered

than the A horizon of Type 2, nevertheless, in arranging the clays in that order certain trends become evident from which valuable information can be secured regarding the manner in which chemical weathering progressed in the locality. The interpretation of the data further brings about differences due to the orographic or hydrographic variations in the soil types. For such a discussion the molecular ratios as given in Tables III, V and VII have been averaged for the layers of the same horizon in a type and the data obtained are presented below for the sake of comparison (Table VIII).

TABLE VIII

Effect of soil development on the molecular ratios

Soil type	Horizon	SiO_2 / R_2O_3	SiO_2 / Al_2O_3	SiO_2 / Fe_2O_3	SiO_2 / $RO+R_2O$	SiO_2 / H_2O	Ex. cap. m.e.
Type 1 . . .	C	2·995	3·870	12·66	3·53	0·66	81·5
	B	2·675	3·355	13·24	4·30	0·74	72·8
	A	2·604	3·190	14·16	5·13	0·73	69·5
Type 2 . . .	C	2·668	3·016	23·09	5·32	0·64	67·0
	B	2·913	3·088	29·20	6·23	0·74	65·5
	A	2·803	2·925	67·28	7·50	0·70	76·0
Type 3 . . .	C	2·655	2·661	..	7·89	0·58	68·0
	B	2·657	2·743	86·18	7·30	0·75	79·5
	A	2·889	2·934	250·60	9·18	0·82	81·5

Whereas in Type 1 the silica-sesquioxide ratios decrease regularly with advanced development, in Type 2 the maximum value is found in B horizon and in Type 3 ratios increase with development. The Type 1 soil being high-lying and open in texture allows free leaching of silica but sesquioxides are left behind at the seat of weathering ; but in Type 2 which lies on a flater topography accumulation of sesquioxides in top layers is not noticeable as maximum concentration of these ingredients is found in the B horizon. When we examine the development in the low-lying Type 3 soils an entirely different picture, viz. the resilication of the weathered products, is obtained. A far better idea of these important pedogenic processes may be secured by considering the silica-alumina ratios. It is evident that in Type 1 the ratios decrease rather rapidly from C to A horizons ; in Type 2 these ratios have become more or less stable but there is slight increase in the B horizon ; whereas, in Type 3 the ratios increase, although not to the same extent as they decreased in Type 1, from C to A horizons. These considerations point to the obvious conclusion that in the sesquioxides it is the alumina component which is more stable or takes part in the process of resilication, and this fact is further corroborated by an examination of the trend of variation in the silica-iron oxide ratios which have in general shown a regular increase with the process of soil development. The silica-base ratios likewise increase with advancing soil maturation showing that as the soil develops, more of the alkaline and alkaline-earth silicates are being attacked—a fact which has already been mentioned previously. With the exception of the A horizon of Type 2 the exchange capacity follows the trend of the variation in the silica-alumina ratios.

It may be of interest to reconsider in the light of the analytical data now obtained for the fractionated clay separates the evidences presented in Part I of this series regarding the classification of these soils into, ' tropical tschernozems '. Sigmond [1939] mentions that in the formation of tschernozems the bases released during the weathering of silicates are only slightly leached out. The easily soluble alkali salts are removed almost completely, but the less easily soluble salts of calcium and magnesium are only partly removed. The characteristic feature in the dynamics of such soil types observed for the Russian and American tschernozems has been found to be the

immobility of the sesquioxides both iron oxide and alumina. Moreover, the mineral composition of the whole profile has been reported to be practically the same. In the present case the results of analysis of the clay fractions do not in general point to the constant character of the mineral composition in the profile but the data obtained are very much similar to those obtained for other soils of the tschernozem type [Byers, Alexandar and Holmes, 1935]. The silica-alumina ratios of the clay complex show an essentially constant character but iron oxide seems to be affected differently in different soil types. This anomalous behaviour of iron oxide may be ascribed to the higher temperatures prevailing in the tropics which presumably exert greater disruptive action on the ferromagnesian minerals. With the exception of this notable variation, the soil clays in general show all the important characteristics of tschernozems and zonally these soils may perhaps be regarded as being typical of the ' tropical tschernozems '.

Minerals in clays have been indentified by X-ray diffraction methods, differential thermal methods and electron microscopic techniques but the chemical data can at best afford only an indication towards a recognition of the probable mineral composition of the clays. Thus Hendricks and Alexandar [1939] have described methods for the identification of clay minerals on the basis of the results of chemical analysis. The greater base exchange capacity (63-84 m.e. per 100 gm.) of all the clays in the three soil types of the Bundelkhand region, the higher combined iron and megnesium contents and the amount of water held after heating to 105°C. suggest that the major constituents of the clay minerals are of the montmorillonite type with probably varying proportions of hydrous micas.

Type 1 and Type 3 soils of the Bundelkhand region are respectively the typical red and black soils of the locality, which are more or less similar in morphological characters to the red and black soils found in Central or Southern India. It may be interesting to compare the data obtained for the Bundelkhand soil types with those obtained for similar associated types in other parts of the country as reported by Raychaudhuri and associates. Raychaudhuri, Sulaiman and Bhuiyan [1943] report that the black soil clays show a higher base exchange capacity than the red ones and that the base exchange capacity decreases down the profile of the black soil whereas with the red soil type it shows a maximum at an intermediate depth. In the case of Bundelkhand soil clays the average values for the base exchange capacity of the black soil type are only slightly higher than those for the red type for the A and B horizons only but not for the C horizon. The base exchange capacity decreases in the profile with depth in the case of the black soil but increases in the case of the red one. However, the fundamental difference between the base exchange capacity of the red and black soil clays isolated from the Coimbatore soils and those isolated from the Bundelkhand soils lies in their absolute values. In the former case the values ranged from 76·0-80·8 m.e. for the black type and 33·8-36·0 m.e. in the red one ; but in the later case the values found are 69·5-81·5 m.e. and 68-81 m.e. for the red and black soils respectively. Among the other fundamental differences observed between the clays from the two soil regions may be mentioned the variations between their values for the silica-alumina and silica-sesquioxide ratios. Whereas, in the case of the Bundelkhand soils these ratios have been found to be slightly higher for the red type as against the black type, in the Coimbatore soils reverse was found to hold good. It appears on a joint consideration of the above facts that in the Coimbatore region the red soils are probably more weathered than the black ones, but in the Bundelkhand area the red soils show immaturity as compared to the black soils. The variations recorded above can, therefore, be ascribed to be due to the genetical differences in the soils of the two regions.

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Summary

1. The clay fractions from the profile samples of the three genetic soil types found in the Bundelkhand region have been thoroughly analysed and the data obtained have been discussed from the stand-point of soil genesis.

2. It has been found that iron oxide and magnesia containing minerals are subjected to greatest amount of weathering under the climatic conditions obtainable in the locality.

3. The processes of soil formation have been followed through the three successive stages of the development of the three profiles and it has been shown that as the weathering progresses more of the alkali and alkaline-earth silicates and ferruginous silicates decompose. The alumina in the complex, however, exhibits some stability.

4. The behaviour of potash, magnesia and iron oxide rendered free after decomposition has been found to be one of the chief pedogenic factors in the genesis and different morphological features of the soil types obtainable in the tract in question.

5. It has been suggested that in the low-lying soil Type 3 some resilication of the cleavage products may further take place mainly due to orographical and hydrographical conditions.

6. The data obtained for the three soil types have also been discussed in the light of the classification of these soils. It appears that these soils are zonally the 'tropical tschernozems' but in the immature Type 1 some evidence has been found of slight lateritic tendencies.

7. Evidence has been adduced to show that the minerals of the soil clays are essentially of the montmorillonite type.

8. The data obtained for the red and black soils of the Bundelkhand region have been compared with those obtained for the similar contrasted soils found near Coimbatore and reported by Raychaudhuri, Sulaiman and Bhuiyan [1943]. The variations observed have been ascribed to be due to differences in the genesis of the two types in the two soil regions.

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EXPERIMENTS ON GREEN MANURE CROP CULTURE AS A MEASURE OF CONTROL OF *A. CULICIFACIES* BREEDING IN PADDY FIELDS

By S. G. Masilamani, Malariologist (Retired), Vepery, Madras, South India, and H. Ramoo, Entomological Assistant, Regional Malaria Organization, Pattukottai

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IN Pattukottai *taluk*, Tanjore District, South India, an irrigation system for rice cultivation was established, where there was no such canal system existing before, and immediately malaria broke out extensively, though not in an acute epidemic form. This *taluk* has an area of 677 square miles comprising 371 villages with a population of 302,194. But the peculiar feature was that malaria did not establish itself; the presumption by the Rockefeller Foundation workers that the area became endemic for malaria and would remain so became falsified, since malaria disappeared completely from the area except for a few cases here and there. That is, there had been a natural decline and disappearance of malaria. While attempting to discover the factors at work which produced the original epidemic, and how these factors became self-controlled, without the conscious intervention of man (no anti-malarial measures were adopted at all except in a field station where investigation was being carried out), it occurred to the senior author that the important factor must have been the output of *A. culicifacies*, that is progressive cultivation decreased the area available for continuous breeding of *A. culicifacies*. A paper on this thesis is being separately published. In the present paper the factor of rice fields alone in malariogenesis and a possible method of controlling it, are considered. An experimental study was carried out for this purpose.

This experimental study, reported below, was carried out as a part of the programme of a scheme of experimental control of rural malaria in Pattukottai *taluk*. The epidemiology of malaria in this area was discussed at some length by Russell, Rao, and Menon [1938] as a result of the investigations carried out by them in this area during the period extending from July, 1936, to March, 1938, under the auspices of the International Health Division of the Rockefeller Foundation and with the co-operation of the Madras Public Health Department.

To have a fuller understanding of the scope, objects and aims of the experimental study under discussion the following few salient epidemiological features of this area need stressing here :

(*a*) Malaria is a recent introduction to this area as a result of conditions brought about by the operation of Cauvery-Mettur new Irrigation Project.

(*b*) *A. culicifacies* which has been incriminated as the vector of this area, though ubiquitous in its breeding habits, has an intimate association with irrigation water.

(*c*) There is a marked ' malaria season ' coinciding with the irrigation season from July to January. The peak prevalence of the local vector was during the first half of this ' on-season ' for malaria.

(*d*) Paddy fields also breed anopheline larvæ, but the species found in a paddy field was governed by the condition or stage of cultivation.

3. According to the finding of the Rockefeller Foundation workers the order of importance of the various types of breeding places from the point of view of frequency of collection of *A. culicifacies* is as follows :

(1) Irrigation canals,
(2) Field channels,
(3) Hoof-marks, cart-tracks,
(4) Ditches,
(5) Seepage pools,
(6) Waste irrigation water,
(7) Borrow pits,
(8) Fallow fields,
(9) Rain water pools,
(10) Wells,
(11) Tanks,
(12) Growing rice fields.

The senior author took charge of the scheme in April, 1942, after investigation by the Rockefeller Foundation workers for five and a half years. Further investigation indicated that if at all there was an important source of *A. culicifacies* as things stood at the time, it was the paddy fields, and the immense importance of rice fields in the epidemiology of malaria in a permanently endemic area irrigated by canal systems (as contrasted with irrigation under wells and small tanks) was revealed.

A. culicifacies is said to be a poor vector and it becomes an important vector only because of its density of prevalence [Russell and Rao, 1942,1]. Assuming this hypothesis to be correct a particular kind of breeding place of this species must be of greater importance on account of its extent and length of period of suitability for breeding, particularly in relation to the transmission season, than other breeding places which are not of much significance in these respects. Apart from factors making a breeding place particularly suitable to *A. culicifacies* its output may be considered to be proportionate to the effective area available for breeding. *A. culicifacies* larvæ were collected generally within 6 in. of the margin of channels, from the whole-water-surface practically of small borrowpits and wells, within about three feet of margins of tanks, and the whole area of paddy fields. Also it was noticed that at any one time only about $\frac{1}{3}$ of the total area of paddy fields in a village was found suitable for the breeding of *A. culicifacies*, the rest being in a state or stage of paddy growth in which no *A. culicifacies* breeding could be found ; wet fallow-state, before ploughing is a very fruitful source of *A. culicifacies*. The actual area available for breeding in the different kinds of breeding places, was actually measured in six villages and it was found that paddy fields constituted about 86 per cent of effective breeding area. Under instructions from the senior author as Malaria Officer, Madras, this unit collected some preliminary data in this respect during 1940. The figures obtained during 1943 are furnished in Table I, showing the relative importance of the various types of *A. culicifacies* breeding places. The larvæ coefficient per visit for the different habitats was worked out as a result of routine observations during a period of one year in 19 villages.

TABLE I

Relative importance of A. culicifacies *breeding places*

Villages	Tanks	Wells	Pits	Main channels	Field channels, *Kannis* and drains	Paddy fields
1. Mudalcheri	26500	1920	173300	23800	40200	6180000
2. Muthakurichi (Kandiankadu)	29300	810	4700	15300	2100	915000
3. Sendankadu (Surankadu)	11580	1320	14700	9260	12320	3120000
4. Sendakottai (Maliakadu)	930	3520	35950	10850	9100	3430000
5. Thuvaranmurichi (Keelakkadu)	31050	710	27940	10460	14100	3700000
6. Karambayam (Kathirikollai)	17100	1410	144960	9730	3500	7850000
Total of breeding area in sq. ft.	116460	9690	401550	79400	81320	25195000
Percentage of breeding areas to total breeding areas	0·45	0·04	1·55	0·31	0·31	97·34
Larvae coefficient per visit	0·40	3·20	1·90	7·60	8·50	0·50
Area × coefficient	46584	31008	762945	603440	691220	12597500
Percentage of area as reduced by coefficient	0·32	0·21	5·19	3·76	4·72	85·80

NOTE.—Larvae coefficient No. of *A. culicifacies* larvae per visit, time being constant.
Breeding areas calculated as follows :
(1) Tanks—peripheral length × 3 ft. width.
(2) Wells and pits—whole area.
(3) Main and branch channels of width not less than 8 ft. length of both edges × one foot.
(4) Field bothies, *kannis* and field drains—length of both edges × 4in. (Radius of dipper 3 in.).
(5) Fields—total wet ayyacut × 0·3273.

Even though the density of breeding of *A. culicifacies* below in paddy fields, the total output of the adult mosquito from this source must be great indeed in proportion to the enormous extent of the available breeding area. That being so, the control of *A. culicifacies* need be confined to only paddy fields, for the purpose of controlling malaria in a rice field area or country irrigated by extensive canals and where the vector species is only *A. culicifacies*.

A. culicifacies though occurring throughout the year showed marked seasonal trends. In June and July, i.e. immediately after the letting in of irrigation water into this area, a rapid rise in the output of adults and larvae occurs and is continued up to August and September with the peak prevalence in August. This rise commences when the relative humidity is low, an unfavourable factor. Other meteorological conditions such as temperature, saturation deficiency and rainfall also seem adverse at the period of the rise. And what is more strange is that when meteorological factors are favourable after September the prevalence of this mosquito drops down abruptly. No satisfactory explanation for this was forthcoming. Perhaps an explanation for this rather strange phenomenon is the availability of the most suitable breeding places (paddy fields in the early cultivation stages) to an enormous extent in the early part of the season and the tremendous output in them masking every other factor and the non-availiability of such breeding places in the latter part of the season, all the other breeding places remaining fairly constant in size. Russell and Rao [1942,2] had reported that from mid-August to mid-October the mortality rate of *A. culicifacies* imagines is about 50 per cent every two days. It is therefore apparent from this that the mortality during the preceding hot dry months must be greater still. To build up such a high and increasing populations in the face of high mortality during these months the breeding places and the output of *A. culicifacies* in them must necessarily be enormous. This should forcibly stress the importance of wet fallow rice fields during this period which outstrips all adverse factors. *A. culicifacies* breeds usually profusely in small grass-free pools. This kind of breeding places will be seen extensively in a wet-fallow field, and hence its importance in the output of *A. culicifacies*.

All the developed fields in this newly irrigated area are not brought under cultivation simultaneously during the irrigation season because of the poor economic condition of the ryots and due to various other reasons. Owing to lack of uniformity in agricultural practices it is very common to see large areas lying in a wet fallow condition for longer periods than necessary till August or September. The wet fallow conditions begin in June and after variations and increase in their area according to progress of cultivation practically completely disappear by end of September or middle of October. One of the reasons advanced for the absence of malaria in some of the old deltaic villages of Tanjore district is that the rice fields in the old delta remain wet fallow for very much shorter period prior to transplantation than in the Grand Anicut Canal area (Pattukottai *taluk*). Any method which abolishes or reduces the breeding of *A. culicifacies* in rice fields during the period of its peak prevalence should be of great importance in the control of malaria in this area. Three methods of malaria control were recommended for this area by the Rockefeller Foundation workers. They were tried in a small area on an experimental basis but it was found that if these methods were applied to the whole *taluk*, the cost would be prohibitive running to more than a crore of rupees perhaps. Moreover, they were found to be impracticable.

In the meanwhile it was considered that the growing of green manure crop would possibly help in controlling of breeding of *A. culicifacies* and hence act as a malaria control measure ultimately in this area. This is entirely a new method. Its rationale will be clear from the following discussion.

(*a*) It has been observed recently in the Cauvery-Mettur Project area that active breeding of *A. culicifacies* in rice fields continues with maximum density as the phases of cultural operations such as ploughing planting and growing stages take place until the rice plants are about a foot high after which the fields are no longer dangerous in this respect. It would appear likely that rice plants above a foot in height inhibit the oviposition of *A. culicifacies*. The decline of *A. culicifacies* adults commencing from October is also interesting in this area as it is not due to any adverse meteorological conditions (as a matter of fact meteorological conditions are more favourable after October) or reduction in the area of breeding places. It may perhaps be due to the disappearance of the particularly favourable breeding places to this species especially the wet fallow rice fields. By October end

very few fields. only a negligible proportion of the total cultivated area, are in existence in the wet fallow condition or the earlier stages of agricultural operations, majority of the fields being in the vegetative phase with crop over one foot high. All these are suggestive of the epidemiological importance of rice fields prior to the active vegetative phase and the need for controlling *A. culicifacies* breeding during this period.

(*b*) In his report No. 62 dated 4th March 1912 Ross had stated "during the rainy months of December and until the middle of January the larvae and nymph of *culicifacies* were found in every pool mingled in places with *rossi* but in the paddy land between Kathiavakkam Village and the canal. the larvae caught were either *fuliginosus* or *rossi*. By the middle of January. pools had begun to shrink and their edges became green with grass : from this time until the time of writing *Neocellia fowleri* and a species (not anopheline) identified as *Aedomyia squammipenna* replaced *culicifacies* and *rossi* in most grass edged pools though in the casurina plantation pits where grass does not grow *culicifacies* hold sway". In his preliminary report on Pattukottai area dated September 1936 the senior author had stated that " paddy fields breed anopheline larvae but the species found in a particular field was governed by the condition or stage of cultivation".

Considering together the observations made by Ross, the senior author of this article and Russell and Rao [1942,3] it would appear that the virtue of obstruction need not be considered peculiar to paddy of more than one foot high. Probably paddy crop of one foot and more in height acts not on account of its height but because of the thick foliage of paddy blades. The senior author knows very well the area referred to by Ross in 1912. The grass cannot be characterized as one foot high and more. It will be mostly less than this from about 3 to 6 in. It will be more correct to say that *A. culicifacies* prefers for oviposition grass free edges. And if further studies are made it may be possible to say that it is a question of vegetation free edges (emergent vegetation of sufficient thickness and height above water surface), and not necessarily paddy-free or grass-free edges. Large scale studies on this point are likely to be of great value as there is the possibility of devising suitable naturalistic methods of control of *A. culicifacies* as a result of such studies. It was argued that if during the wet fallow condition of the fields there is already a standing crop there to prevent oviposition by *A. culicifacies* the breeding of this mosquito in paddy fields would be controlled. And if this standing crop is useful to the agriculturists also then two purposes will be served.—

(i) Prevention of *A. culicifacies* breeding ; and (ii) Utility to ryot.

A green manure crop was found to answer the requirements.

These observations led us to presume that a thick growth of a green manure crop in rice fields must certainly offer sufficient mechanical obstruction to keep. *A. culicifacies* out of them and therefore experimental studies were planned.

(*c*) All the green manure crops that are used for agricultural purposes belong to the leguminous type and it is a well known fact that legumes fix in the soil the nitrogen of the atmosphere by certain bacterial action thereby increasing the nitrogenous contents of the soil. The soil in this new project area is reputed to be deficient in humus and nitrogenous contents. It is an accepted fact that many anopheline species particularly those concerned in the transmission of malaria avoid water, the nitrogenous content of which is high. Hence the possibility is that a well manured paddy field in due course of time may prevent *A. culicifacies* breeding. (The manurial problem in the Grand Anicut Canal area is said to be difficult if not acute as there is great scarcity of farm yard manure). In the case of fields with the green manure crop the manure plants are ploughed and puddled into the soil in the very first ploughing and during the whole period the fields are in this phase of ploughing and puddling, a high degree of organic pollution and contamination of the wet field take place so as to inhibit *A. culicifacies* breeding.

(*d*) It has been estimated by the Agriculture Department that the raising of green manure crop in rice fields increases the yield of paddy by at least 50 per cent in a soil newly brought under cultivation and by 10 to 25 per cent in old soil. This would certainly go a long way in bettering the economic condition of the ryots. It has already been mentioned that the generally poor economic condition of the ryots of this area had been the chief limiting factor in the rapid development of the new irrigation area both in regard to intensive and extensive cultivation which constitute probably by itself an

important method of irrigation-malaria control. That it is considered by some that improvement in the economic condition of a malaria-stricken community is helpful in malaria control needs no reiteration.

Experimental study

Two villages namely Veppangulam and Thallikottai on the Pattukottai-Mannargudi road were selected for the study in 1943. The manure crops tried were *kolingi*, *daincha* and sunnhemp. A complete belt of lands around each village was sown with the above crops. The total of 215 acres was under *kolingi*, 9½ acres under *daincha* and 82·69 acres under sunnhemp in the two villages. A brief description of the three plants and the time of their sowing, etc. is given below.

Kolingi (*Tephrosia purpurea*)

This is a wild growing herb with plenty of lateral branches and thick foliage. It grows to a height of about 2 to 3 ft. A thick growth of these plants is capable of affording effective shade as well as mechanical obstruction to the ovipositing female *A. culicifacies* mosquitoes in a way that any water stagnation in the field is completely hidden. These plants grow well only in comparatively dry soil and in their wild growth are often found abundantly only during the dry summer months. They wither under water-logged or wet conditions. When water stagnates for about a fortnight in the fields in which these plants have been grown they die out, but they produce conditions inhibitive to *A. culicifacies* breeding by organic pollution of the water by the rotting of fallen leaves and shoots. They are usually sown in rice fields when the previous paddy crop is nearing harvest, a week or ten days before the harvest, when there would be some water left in the field which would be useful for the germination of the seeds. By the time these seeds sprout out the harvest of the paddy would be over and the moisture that would be left in the soil of the harvested field would be sufficient to give a start for the young seedlings. No further watering is necessary. In the present experiments these were sown only a week before the harvest during the second week of January 1943. The one important advantage of this particular crop over the others is that if it is given a start by persistent sowing for two or three years it ultimately establishes itself without the need for subsequent sowing. This is due to the fact that a certain percentage of the seeds, that are ploughed into the soil, is capable of lying dormant in the soil for long periods, one year even ordinarily, and then sprouting when the soil becomes semi-moist. These plants are usually grown in fields which are not moist during summer and non-irrigation season and are of a sandy loamy nature. In the Grand Anicut Canal area fields which are moist or semi-moist during the non-irrigation dry season constitute only a very small percentage of the total paddy crop area. From our general observations it can be said that this plant can be tried as a green manure crop for at least 90 per cent of the developed ayyacut in the Grand Anicut Canal area the rest being in a marshy or damp condition, a condition unsuited to the growth of this plant.

Daincha (*Sesbania aculeata*)

This is a downy shrub which sometimes grows to a height of 6 to 8 ft. It gives off lateral branches only after it has grown up to a certain height and has a rapid growth. It is therefore grown only after the letting in of irrigation-water in June and will be useful for fields wherein agricultural operations commence by or after the middle of August or so and which are unsuitable for the growth of *kolingi* on account of the nature of the soil. During the early stages of its growth for a month or so it is not of much use from the point of providing either dense shade or mechanical obstruction to the required degree but since the ryot will take care that the field is not water-logged for fear of destruction of the plant this defect is not of much significance. As it advances in age a thick growth with plenty of lateral branches provide good mechanical obstruction.

Sunnhemp (*Crotalaria juncea*)

This is a plant which can be said to be neither a herb nor a shrub but is midway between them. It grows up to a height of 4 to 5 ft. It gives off only a few lateral branches at the tips just before the

flowering stage. The foliage is also moderate. It has to be sown after the letting in of irrigation water just as *daincha* with an initial wetting and ploughing. This seems to require a certain amount of moisture in the soil for its good growth but does not stand marshy or damp condition. It is a very short duration crop of say 40 or 45 days—this seems to be its only advantage. But since it does not give off lateral shoots or foliage and since it is subject to attacks of a pest, it was considered of not much practical value in control of *A. culicifacies* breeding and the results of observation on this plant are therefore omitted from the report.

These experiments were planned and relevant data collected in such a way as to determine chiefly the effects of green manure crop culture on *A. culicifacies* breeding in rice fields at the various stages of agricultural operations. No attempt was made to study the incidence of malaria in the villages around which green manure crops were grown as malaria in this Grand Anicut Canal area was at the time of starting these experiments found to be rapidly declining. Moreover, if a study of the incidence of malaria in relation to this method of control was made the scope and extent of the experiment must necessarily have been bigger. Such a large scale study was not necessary since the only point to be proved was whether green manure crop culture would control breeding of *A. culicifacies* in paddy fields or not and if it did control such breeding the legitimate inference can be that the malaria also will be controlled since rice fields constitute 86 per cent of the effective area for its breeding. Anopheline larvae were collected in the above fields. A total of about 2070 collections were made. Standardized method of larvae collection was uniformly adopted, each collection being for a constant period of five minutes.

As the wet condition of the fields varies week after week, larvae collections were made in as many fields as were in the wet condition and over a wide area. Further, these observations were carried out in a larger area under actual field conditions so that the data collected might give a clearer idea than the data gathered in a few selected experimental plots. The figures, viz. the total number of *A. culicifacies* identified from the collections and the percentage of *A. culicifacies* to the total larvae identified, furnished in Table II, give a clear and conclusive indication of the inhibitive effects of green manure crops on *A. culicifacies* breeding in rice fields. Collections in fields with dense growth of *kolingi* were negative for *A. culicifacies*, while in the fields with dense growth of *daincha* and moderate growth of *kolingi*, the percentage of *A. culicifacies* was less than 4 per cent. In this connection it must be mentioned that green manure crop culture is a new introduction to this area and particularly in the villages where they were tried by us. Owing to abnormal summer showers in 1943 and lack of sufficient co-operation from the ryots, the green manure crops were successfully raised to the desired effect only on a small portion of the total area under green manure crop. When once this practice is earnestly taken up by the ryots and is established firmly, dense growth of green manure crop can effectively be raised. In contrast to the percentage of *A. culicifacies* in the fields with green manure crop, the figures obtained in the control fields with no *kolingi* was as high as 13·7 per cent. Even fields with moderate growth of *kolingi* recorded only 3·2 per cent of *A. culicifacies* larvae which is less than 25 per cent of the figures for the control fields. Fields ploughed with the green manure crop also showed practically negative figures for *A. culicifacies* breeding and this inhibitive effect was noticeable even to the stage of paddy crop coming up to a height of one foot after transplantation. The percentage of *A. culicifacies* in the fields ploughed without green manure crop was also as high as 16·6 per cent. From the above statements it may be seen that the frequency of collection of *A. culicifacies* larvae was considerably greater in the control fields (wet fallow without green manure crop and wet fallow ploughed without green manure), than in the experimental fields (wet fields with green manure). In collections in which only one or two *A. culicifacies* larvae were recorded the possibility of their presence due to the larval drift from the field channels through which the fields have been watered should not be ruled out and must be borne in mind in studying the data furnished.

A 50 per cent reduction of *A. culicifacies* is all that is necessary to abolish effective transmission, since this species is a very poor vector in this area with an infection index of 0·1 per cent. It is generally so in non-epidemic areas. It is the density, that is larger output, that seems to be the important factor. Viewed in this way the effect produced by green manure crop culture on *A. culicifacies* output is more than satisfactory.

With a view to confirm the observations carried out in 1943, experimental studies were continued in this respect, during the irrigation and agricultural season of 1944 and 1945. In 1944 six villages were selected for observations. Only a few acres of land in each village were kept under green manure crop. Owing to complete failure of summer showers and the quality of seeds then available with poor germination rate, the crops raised were not to the desired effect. Observations were carried out (week by week) this year in selected plots till the paddy crop grew up to a height of one foot. A summary of the results of the observations is furnished in Table III. A few further observations on the lines of study in 1943 were made during 1945 also and a summary of the data collected is furnished in Table IV. It may be seen from these figures that the first year's observations have been amply confirmed.

TABLE II

Consolidated statement of larvae collections in rice fields during 1943

Habitat	Total No. of			Percentage of *A. culicifacies* larvae to the total identified
	Larvae collections	Anopheline larvae identified	*A. culicifacies* larvae identified	
Wet fallow field with thick growth of *kolingi* crop	42	334	..	..
Wet fallow field with moderate growth of *kolingi* crop	358	1982	64	3·2
Wet fallow field without *kolingi* crop (control)	591	2876	395	13·7
Wet fallow field ploughed with *kolingi* crop	315	2133	20	0·9
Wet fallow field ploughed without *kolingi* (control)	132	805	134	16·6
Wet fallow field with thick growth of *daincha* crop	67	414	16	3·86
Wet fallow field ploughed with *daincha* crop	46	30	..	..
Growing rice field with paddy crop of less than 1 foot height (*daincha* previously grown).	43	109		..
Growing rice field with paddy crop of less than 1 foot height (*kolingi* previously grown).	300	738	..	

TABLE III

Consolidated statement of larvae collections in rice fields during 1944

Habitat	Total No. of			Percentage of *A. culicifacies* larvae to the total identified
	Larvae collections	Anopheline larvae identified	*A. culicifacies* larvae identified	
Wet fallow field with thick growth of *kolingi* crop	55	663	6	0·9
Wet fallow field with poor growth of *kolingi* crop	56	812	39	4·8
Wet fallow field without *kolingi* (control)	54	867	64	7·4
Wet fallow field with thick growth of *kolingi* after ploughing	33	493	1	0·2
Wet fallow field with poor growth of *kolingi* after ploughing	23	393	11	2·8
Wet fallow field without *kolingi* after ploughing (control)	26	486	11	2·3

TABLE IV

Consolidated statement of larvae collections in rice fields during 1945

Habitat	Total No. of			Percentage of *A. culicifacies* larvae to the total identified
	Larvae collections	Anopheline larvae identified	*A. culicifacies* larvae identified	
Wet fallow field with thick growth of *kolingi* crop	12	273	..	..
Wet fallow field with moderate growth of *kolingi* crop	2	170	..	..
Wet fallow field with thick growth of *daincha* crop	11	177	..	..
Wet fallow field ploughed with green manure crops	11	155	1	0·6
Growing rice field with paddy crop of less than 1 foot height previously grown with green manure crop	2	9	..	..
Wet fallow field without *kolingi* (control)	65	757	89	11·8

SUMMARY

Green manure crops do effectively create conditions in rice fields during the various stages of agricultural operations inhibitive to *A. culicifacies* breeding, the one or the other or a combination of factors enumerated in this paper coming into play during the peak months of *A. culicifacies* breeding in the Grand Anicut Canal area.

Kolingi seems to be the most suitable green manure crop to this area. In other places where similar problem obtains, the agricultural expert may suggest, in consultation with the malariologist, the most suitable manure crop for the local soil.

The growing of green manure crop solves also the manurial problem in the Grand Anicut Canal area where the soil is said to be poor and farm yard manure difficult to obtain.

Increased yield and the consequent betterment in the economic condition of the ryot.

The possibility of this method of malaria control proving an unique naturalistic method of control against *A. culicifacies* breeding in rice fields, particularly in deltaic and new irrigation area subjected to agricultural or irrigation malaria is indicated. There are many kinds of green manure crops and it may not be difficult to select a suitable one.

To foresee and prevent outbreaks of malaria in areas to be newly brought under canal irrigation (outbreaks like those which occurred in the Irwin Canal area in Mysore and Grand Anicut Canal area in Tanjore district), it may perhaps be enough that a scheme of extensive green manure culture properly designed and executed is put into operation, even before the first cultivation commences.

Malaria in India is mainly a rural problem and if careful investigations are made, the problem will more often be found associated with agriculture. Apart from the water-tidiness that must be practised in the distribution of water there is yet the question of the agricultural practice itself.

The method of green manure crop culture is strictly in imitation of nature The problem of rural malaria is so enormous and extensive that it will be the height of folly to think of the present-day methods which are usually costly. It is suggested that methods like green manure crop culture and others which can be brought under ' sanitated agriculture ' may be taken up for intensive study as an item in rural reconstruction and postwar reconstruction.

A scheme of green manure crop culture as a malaria control measure will not cost the Government anything at all except the money spent on propaganda which is ordinarily a legitimate expenditure of the Agriculture Department. The expenditure on green manure crop will finally become part of the ryots' agricultural budget and it will not be felt as an extraordinary expenditure at all. That is to say he himself will be establishing malaria control and it will cost him next to nothing to do this.

There are many new irrigation projects coming into existence shortly. It is suggesred that it will be worthwhile to investigate naturalistic methods of control and put into practice any useful ones in connection with these projects before it is too late.

The method of green manure crop culture establishes continuous control of breeding of *A. culicifacies* from the time water is let into a rice field, accidentally or intentionally, till the time when the height of paddy growth itself is sufficient to prevent oviposition. Malaria transmission will be abolished every year and the disease will finally die a natural death.

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CONTROL OF *BRACON BREVICORNIS* WASMEAL, A PARASITE OF *CORCYRA CEPHALONICA* ST., A HOST FOR MASS BREEDING OF *TRICHOGRAMMA MINUTUM* RILEY

By K. N. Trehan, M. Sc., Ph. D. (Lond.), Agricultural Entomologist to Government, Bombay Province, Poona, and S. A. Raja Rao, M. Sc., Entomological Officer, Biological Control Scheme, Bombay

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BRACON BREVICORNIS Wasmeal has been recorded on Pink boll worm. It also attacks the caterpillars of *Corcyra cephalonica* St. which is employed for the mass production of *Trichogramma minutum* Riley. At times the attack of this *Bracon* is so serious that it destroys the entire culture of *Corcyra* and thus acts as a serious obstacle in the rapid multiplication of *Trichogramma* parasites. Although the *Bracon* is most active only during May, June and July, its slackened activity during the rest of the year, need not be neglected.

Behaviour and life-history

The adults are very active. After mating, the female rests on the body of the host larva and stings the host which dies subsequently. The parasite has a preference for the 3rd instar larvae. Larvae of 3·0 mm. or less are not attacked, whereas those which are more than 4·0 mm. long and well developed are readily parasitized. In cases of severe infestation, however, even the larvae in last instar or in the prepupal stage are usually not free from the attack. The parasite lays eggs anywhere on the body of the host or close to it. On an average, the duration of the life-cycle during May was eight days, (average maximum temperature 97·23°F.; minimum 73·22°F.; humidity at 8 o'clock 69·88 per cent).

Table I

Life-history of Bracon brevicornis

Eggs laid on	Eggs hatched on	Prepupal & pupal period	Date of emergence	Remarks
1-5-1943	2-5-1943	5th-8th	9-5-1943	Egg stage 1 day
3-5-1943	4-5-1943	7th-10th	11-5-1943	Grub stage 3 days
5-5-1943	6-5-1943	9th-12th	13-5-1943	Prepupal stage 1 day
6-5-1943	7-5-1943	10th-13th	14-5-1943	and Pupal stage 3 days
8-5-1943	9-5-1943	12th-15th	16-5-1943	
9-5-1943	10-5-1943	13th-16th	17-5-1943	
10-5-1943	11-5-1943	14th-17th	18-5-1943	
12-5-1943	13-5-1943	16th-19th	20-5-1943	
14-5-1943	15-5-1943	18th-21st	22-5-1943	

The number of parasites that develop from a single host depends on its size and may range from three to seven. The number of eggs laid by a single female ranged from 16 to 22 (Table II) and the oviposition period was two to three days, the maximum number of eggs being laid in the first 24 hours. The duration of the life of the adults was four to six days.

TABLE II

Egg laying and percentage of daily oviposition per female

Observation	Oviposition			Total	Percentage daily oviposition		
	1st 24 hrs.	2nd 24 hrs.	3rd 24 hrs.		1st 24 hrs.	2nd 24 hrs.	3rd 24 hrs.
1	8	6	2	16	50·0	37·5	12·5
2	7	4	5	16	43·7	25·5	31·3
3	10	6	3	19	52·6	31·5	16·0
4	9	5	3	17	53·0	29·4	17·6
5	10	4	4	18	55·5	22·2	22·2
6	11	5	4	20	55·0	25·0	20·0
7	9	6	4	19	47·4	31·6	21·0
8	12	7	3	22	55·0	32·0	13·0
9	11	6	4	21	52·4	28·6	19·0
10	10	6	5	21	47·6	28·6	23·8
Average	9·7	5·5	3·7	18·9	51·2	29·1	19·6

Description of stages. Adult : Active, male smaller than the female, average length male 3·55 mm., female 4·46 mm.; shows variation in the number of antennal segments which are 22 in male and 16 in female. The antennae are beaded except the last segment which is pear shaped, pedicel the smallest. Egg : Cigar shaped, grey, laid singly, average length 0·5 mm., hatches in about 24 hours in rare cases incubation period may extend to 30 hours. Grub : 0·5 mm. at emergence and on an average, becomes 2·07 mm. long when full grown, slightly curved, it feeds for two to three days, becomes stumpy, detaches itself from the host, and after the prepupal stage of one day, pupates in a silken cocoon. Pupa : slightly broader posteriorly ; average measurements, length 3·17 mm., breadth 1·14 mm.

Original description is given in *Nouv. Acad. Science Bruxelles*, 11 (1838) but the publication is not available anywhere in India.

MEASURES

Preventive

The food material should be spread in sun for a couple of days and well disturbed so that the parasitized larvae, if already present, may be killed. It is always safe to sun-dry even broken *Jowar* before it is used for this purpose.

The breeding cages should be well protected with wire gauze of 30 meshes to a liniar inch, and fumigated with tabacco before use. Soon after the inoculation of *Corcyra* eggs into the food material, breeding cages should be kept closed till the emergence of the moths. Just after collection of the moths, the cages should be carefully examined for any stray parasite which must immediately be destroyed. These precautionary measures must be adopted till practically all the moths have emerged.

Control

Light trap. Results of considerable significance have been achieved by light traps under laboratory conditions. A petromax light of 50 c.p. held in front of the breeding chamber at a distance of 2-5 ft. attracts innumerable parasites of which usually the greater percentage is of gravid females. The culture, however, should be disturbed to increase the efficacy of the trap. Almost 75 per cent control may be achieved by this method.

Ash method. As a rule, after emergence the parasites come to the surface for mating after which they again enter the culture through the interspaces and attack the host larvae. The larvae while feeding, often come near the surface of the food medium and are easily parasitized. Considerable control, however, has been achieved by spreading the ashes obtained by burning the molasses, which

is a byproduct in the manufacture of sugar, in thin and uniform layer of 1·0 cm. thickness over the culture. It provides an additional layer and, therefore, restricts the larval movement only within the food material. Moreover, the parasites after mating do not find easy access into the culture because the interspaces at the top are blocked up. Thus the larvae escape parasitization and breed within the culture quite undisturbed. The layer of ashes does not in any way, hinder either the emergence of moths or the development of their larvae.

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STUDIES IN THE AGRONOMY OF GAORANI COTTONS

1. PREPARATORY TILLAGE AND INTERSEASONAL CULTIVATIONS

By P. D. Gadkari and V. K. Joshi, Department of Agriculture, H. E. H. the Nizam's Dominions

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IMPORTANCE of the preparatory tillage and interseasonal cultivation needs no special emphasis. Every farmer knows that if these basic operations of agriculture are not properly attended to, the yields of his crops are bound to suffer. Cotton yields in Marhatwada have been notoriously low and as such it was felt necessary to find out how far the same could be improved by bringing about suitable changes in the existing tillage operations. This work was started at the Cotton Research Station, Nanded, immediately after the evolution of a basic *bani* strain of cotton, viz. Gaorani 6.

Experiments

The local methods of preparatory tillage and interseasonal cultivations followed for cotton naturally depend upon the previous rotation crop grown in the field assigned for it. In Marhatwada cotton usually follows either *kharif* (monsoon) or *rabi* (cold weather) *jowar* (*Sorghum vulgare*). The cold season or *rabi jowar* is usually preceded by a short season leguminous crop of *mug* (*Phaseolus mungo*). In recent years, however, groundnut (*Archis hypogea*) is becoming widely popular as a rotation crop for cotton. Accordingly, the experiments regarding preparatory tillage and interseasonal cultivations for the same were carried out in relation to all these three crops that are rotated with it.

The local practices of preparatory tillage for cotton consist of :

(*a*) a ploughing (with a heavy wooden plough) once in four years, and

(*b*) annual *bakharings* with a blade harrow as per following details :

(1) After *kharif jowar :*

(i) Two *bakharings*, one immediately after *Ugadi*, i.e. middle of April and another after the break of south-west monsoon sometime in the first or second week of June : or

(ii) Three *bakharings*, one immediately after *Ugadi*, i.e. middle of April ; another a month after the first *bakharing*, advantage being taken of any ante-monsoon showers that may be received and a third just after the break of south-west monsoon, sometime in the first or second week of June.

(2) After *rabi jowar :*

(i) One *bakharing* given just after the commencement of the south-west monsoon sometime in the first or second week of June; or

(ii) Two *bakharings*, one given immediately after the *Ugadi* and the other immediately after the commencement of the south-west monsoon ; or

(iii) Three *bakharings*, the first at *Ugadi*, second a month after *Ugadi* (advantage taken of any ante-monsoon showers) and third given just after the break of the south-west monsoon.

(3) After *groundnut :*

(i) Two *bakharings*, one immediately after the harvest of the groundnut crop (virtually a part of the harvesting operation itself) and another after commencement of the south-west monsoon.

The local methods of interseasonal cultivation consist of :

(*a*) two hoeings with *kolpa* (blade hoe); and

(*b*) one or two weedings carried out with the help of a *khurpi*, no difference being made due to previous rotations.

It will be noted from the above details of the preparatory tillage that these operations commence only after *Ugadi*, i.e. middle of April. This is probably due to the fact that the land leases in these parts are renewed on or about this day, which marks the beginning of the agricultural new year. The inevitable result of this practice is that the lands are totally neglected after the harvest of the

previous crop till the right for growing next year's crop is decided. It is usually believed that lack of preparatory tillage during this period may be responsible for lowering the yields of the following cotton crop. Accordingly in the experiment conducted after *kharif jowar*, where the land usually remains uncultivated for a long period till *Ugadi*, one *bakharing* immediately after its harvest was added to both the local practices cited above. Similarly, in case of groundnut rotation, an extra ploughing with an wooden plough in mid-January, or one bakharing at *Ugadi*, or both, were added to the existing local practice of preparatory tillage for cotton grown after this crop. In case of *rabi jowar*, however, the question of the land remaining uncultivated between harvest of *rabi jowar* and commencement of tillage operations for the following cotton, did not arise and as such the experiment was confined to the study of the effect of the increased frequency of *bakharing* operations after *Ugadi*.

Each of the preparatory tillage method in each experiment was studied in relation to the frequency of the weeding operations that formed a part of interseasonal cultivation for cotton.

Thus, each experiment consisted of eight treatments due to four levels of preparatory tillage (as detailed in Table I) and two levels of hand weedings, viz. once (on first workable day 35 days after sowing) or twice (on first workable days 30 and 65 days after sowing).

TABLE I

Details of prepartaory tillage treatments tested in the Cotton Cultivation Experiment A, Cotton Research Station, Nanded, 1942-45

After *kharif jowar*	After *rabi jowar*	After groundnut
(1)* Two *bakharings*—one after *Ugadi* and one after the break of south-west monsoon.	(1)* One *bakharing*—after the break of south-west monsoon.	(1)* Two *bakharings*—one at groundnut harvest, another after the commencement of south-west monsoon—ploughing once in four years.
(2) Three *bakharings*—one after harvest of *kharif jowar*, the other at *Ugadi* and the third after commencement of south-west monsoon.	(2)* Two *bakharings*—one after *Ugadi* and one after the break of south-west monsoon.	(2) Three *bakharings*—one at groundnut harvest, another at *Ugadi* and third after commencement of the south-west monsoon—ploughing once in four years.
(3)* Three *bakharings*—one after *Ugadi*, one after a month and the third after the break of south-west monsoon.	(3)* Three *bakharings*—one after *Ugadi*, one a month later and one after break of south-west monsoon.	(3) Two *bakharings*—one at groundnut harvest, another after the commencement of south-west monsoon—ploughing once in two years.
(4) Four *bakharings*—one after harvest of *kharif jowar*, one at *Ugadi*, one a month later and one after the break of south-west monsoon.	(4) Four *bakharings*—one after *Ugadi*, one each in April and May at successive intervals of three weeks after *Ugadi bakharing* and one after the break of south-west monsoon.	(4) Three *bakharings*—one at groundnut harvest, another at *Ugadi*, and third after commencement of the south-west monsoon—ploughing once in two years.

* Local practices

In addition to the above treatment operations all the plots of cotton whether grown after *kharif jowar*, *rabi jowar* or groundnut were subject to usual hoeing operations.

Each experiment consisted of five randomized blocks, each block having eight plots—one corresponding to a treatment. Each plot was $60\frac{1}{2}$ ft. $\times 19\frac{1}{2}$ ft. and had 12 rows, each row being $60\frac{1}{2}$ ft. long, distance between rows being 18 in. Two rows on either flank of the plot and 2 ft. 9 in. length of each row on either extremity were treated as non-experimental. The net plot size was, therefore, 1/66 acre—55 ft. $\times$ 12 ft.

The experiments were conducted during the seasons 1942-43, 1943-44 and 1944-45 at the Cotton Research Station, Nanded, where the soil is a typical black cotton one. The seed of Gaorani 6 was

sown each year at the usual time, exactly as per the local practice of dropping the same through a *mogha* (tube) running behind a *bakhar*.

All the fields had received a tractor ploughing in May 1940 and four years later ploughing with a country plough was given at *Ugadi*, so that differences due to this routine tillage operation were not possible.

In addition to the above experiments regarding preparatory tillage for cotton grown after three rotation crops, another test was conducted during the period 1941 to 1944 to study exclusively the effect of the different methods of interseasonal operations with varying frequencies on the yield of Gaoranib. This experiment was carried out after *kharif jowar* under normal conditions and consisted of the 18 treatment combinations due to three levels of weeding, three levels of hoeing with a bullock hoe and two levels of ridging with Indore ridger. Details of these treatments were as follows :

(*a*) *Weedings* (with a *khurpi*)
- (1) No weeding.
- (2) Weeding once, on the first workable day following 35 days after sowing.
- (3) Weeding twice—first weeding on first workable day following 30 days after sowing, second weeding on first workable day following 65 days after sowing.

(*b*) *Hoeing :* with a *kolpa* (blade hoe) worked by bullocks.
- (1) No hoeing.
- (2) Hoeing once—on the first workable day following 40 days after sowing.
- (3) Hoeing twice—first hoeing on the first workable day following 35 days after sowing and second hoeing on the first workable day following 70 days after sowing.

(*c*) *Ridging* : with Indore ridger worked by bullocks
- (1) No ridging.
- (2) Ridging once—about 80 days after sowing.

The layout of this experiment consisted of three randomized blocks, each block having 18 plots arranged at random. Each plot had 11 rows, 18 in. apart, two rows on either side and 2 ft. 9 in. length on either extremity of all rows being treated as non-experimental so that the net plot size was 1/75·4 acres.

Results

The results of the analyses of variance obtained for yield of seed cotton recorded for three seasons in the experiments mentioned above are given in Tables II, III and IV.

Table II

Analyses of variance for the yields of cotton obtained for three seasons in the cotton cultivation tests conducted at the Cotton Research Station, Nanded, during 1942-45

Due to	Degree of freedom	Mean square of variance	
		After *kharif jowar*	After *rabi jowar*
Seasons	2	11121·5**	16308·7**
Blocks within seasons	12	405·6	206·3**
Bakharings	3	613·4	8·7
Weedings	1	80·4	849·1**
Bakharings × weedings	3	78·8	40·1
Seasons × weedings	2	250·2	240·3
Seasons × *bakharings*	6	81·0	61·9
Seasons × *bakharings* × weedings	6	39·7	57·3
Error	84†	256·6	57·7

† 83 degrees of freedom for *kharif jowar* since one plot in 1943-44 was missing. Similarly 82 degrees of freedom for *rabi jowar* as yield of two plots in 1943-44 were lost and as such calculated as missing

** Significant at 1 per cent level.

TABLE III

Analysis of variance for yields of seed cotton for the three seasons, 1942-45, in the cultivation test after groundnut

Due to	Degrees of freedom	Mean square	Remarks
Blocks	12	1572·3	
Seasons	2	2578·1	
Weedings	1	262·8	
Bakharings	1	563·3	
Ploughings	1	276·6	
Seasons × weedings	2	421·9	
Seasons × *bakharings*	2	85·9	
Seasons × ploughings	2	10·2	
Bakharings × weeding	1	6·3	
Ploughing × weeding	1	14·4	
Ploughing × *bakharing*	1	105·3	
Seasons × *bakharings* × weeding	2	195·2	
Seasons × *bakharings* × ploughing	2	1206·4	
Seasons × ploughing × weeding	2	192·8	
Ploughing × weeding × *bakharing*	1	626·5	
Season × ploughing × weeding × *bakharing*	2	230·6	
Error	83*	257·8	* Yield of one plot in 1944-45 lost—treated as missing

It will be seen from the above analyses of variance that none of the preparatory tillage treatments incorporated in any of the above experiments brought about any 'Significant' differences in the yield of *kapas* of Gaorani 6.

The mean yields of *kapas* (lb. per acre) obtained in the trial for different preparatory tillage treatments for three seasons were as follows :

(1) *After* kharif jowar :

	Bakharings				Mean	S. E.
	Twice—(1) at *Ugadi* and (2) after break of South-West monsoon	Thrice—(1) after *kharif jowar* harvest (2) at *Ugadi* and (3) after break of South-West monsoon	Thrice—(1) at *Ugadi* (2) a month after (3) after break of South-West monsoon	Four times—(1) after *kharif jowar* harvest (2) at *Ugadi* (3) a month after (4) after break of South-West monsoon		
1942-43	194	182	226	203	201	17·5
1943-44	348	317	343	323	333	24·6
1944-45	320	264	324	299	302	18·1
Average for three seasons	287	254	298	275	278	12·1

(2) *After* rabi jowar :

	Bakharings				Mean	S. E.
	Once—after break of South West monsoon	Twice—(1) at *Ugadi* (2) after break of South-West monsoon	Thrice—(1) at *Ugadi* (2) a month after (3) after break of South-West monsoon	Four times—(1) at *Ugadi* (2) and (3) three weeks interval (4) after break of South-West monsoon		
1942-43 . . .	191	183	194	195	191	6·6
1943-44 . . .	108	118	122	129	119	13·1
1944-45 . . .	300	284	283	274	285	8·9
Average for three seasons	200	195	200	200	199	5·7

(3) *After groundnut* :

	Ploughing once in four years		Ploughing once in two years		Mean	S. E.
	Two *bakharings* (1) after groundnut harvest (2) after break of South-West monsoon	Three *bakharings* (1) after groundnut harvest (2) after *Ugadi* (3) after break of South-West monsoon	Two *bakharings* (1) after groundnut harvest (2) after break of South-West monsoon	Three *bakharings* (1) after groundnut harvest (2) after *Ugadi* (3) after break of South-West monsoon		
1942-43 . . .	264	267	288	276	274	17·3
1943-44 . . .	343	253	298	328	306	26·3
1944-45 . . .	333	341	366	318	339	18·3
Average for three seasons	312	287	317	307	306	20·9

Thus it will be seen that increase in the frequency of preparatory tillage operations for cotton to be grown after any of the crops mentioned above does not contribute towards any increase in its *kapas* yield.

Similarly the effect of an extra weeding (in addition to one that must be given) did not show any significant increase in the yield of seed cotton except in case of its being grown after *rabi jowar*. The mean yields of *kapas* (lb. per acre) for three seasons, 1942 to 1945, of Gaorani 6 due to different weeding treatments in the three trials were as follows :

	Weedings with *khurpi*		S. E.	C. D. at 5 per cent
	One only	Two weedings		
After *kharif jowar*	275	282	3·5	—
After *rabi jowar*	188	210	4·0	11·2
After groundnut	300	312	3·6	—

It has been already mentioned that in addition to above experiments, still another cultivation test was conducted to study the effect of different interseasonal cultivation practices on the yield of seed cotton when grown after *kharif jowar*. Table IV gives the analyses of variance for the yield of *kapas* recorded in this experiment for three seasons. A combined analysis for three years' data was not possible due to existence of large differences in the error variances of the three seasons' trials.

TABLE IV

Analyses of variance for yield of seed cotton in the cultivation test 'B' (for post-cultivation operations) conducted at the Cotton Research Station, Nanded, 1941-1944

Due to	Degrees of freedom	Mean square		
		1941-42	1942-43	1943-44
Blocks	2	818·1	492·4	1953
Weedings	2	81538·1**	14450·2**	26046**
Hoeings	2	2230·1	1533·4**	268
Ridgings	1	3639·2	121·0	2334
Weeding × hoeings	4	1865·9	56·4	461
Hoeing × ridging	2	631·7	42·1	589
Weeding × ridging	2	3121·5	91·1	831
Weeding × hoeing × ridging	4	2470·8	84·5	930
Error	34	2861·7	111·4	849·4

**In 1943-44 there ware only 33 degrees of freedom due to yield of one plot being lost (missing plot)

It will be seen from the above analyses that the differences due to 'ridging' were not significant in any of the seasons. This means that Indore ridger does not offer any advantage to the Marhatwada cultivator.

The differences in *kapas* yield due to weedings were significant for all the three seasons and mean yields (lb.) per acre due to these treatments were as follows :

	Pounds per acre			S. E.	Critical difference at 5 per cent level
	No weeding	One weeding	Two weedings		
1941-42	561	*1083*	*1134*	59	171
1942-43	96	*311*	*341*	12	34
1943-44	94	297	452	32	93

It will be seen that the weeded crop gave a significantly higher yield than the unweeded one. This is least surprizing since the weed competition is sure to lower the yields of any crop. It was further noted that, whereas in the first two seasons only one weeding was sufficient, in 1943-44 a second weeding gave a genuine advantage to the crop. This was probably due to the fact that in this particular season abnormally continuous rains after first weeding were recorded so that an additional weeding after it was beneficial.

Hoeing once or twice with a *kolpa* did not offer any benefit during the seasons 1941-42 and 1943-44. However, in 1942-43, the plots that received hoeing gave a significantly higher yield over the ones that were not 'hoed'. There was, however, no difference in yield of *kapas* due to the number of hoeings. The mean *kapas* yields for these treatments for the three seasons were as follows :

	Pounds per acre			S. E.	Critical difference at 5 per cent
	No hoeing	One hoeing	Two hoeings		
1941-42	987	903	889	59	—
1942-43	200	273	276	12	34
1943-44	269	266	299	32	—

The above results show that hand weeding with a *khurpi* alone is an absolutely essential post-sowing operation of the cotton crop.

Discussion

The experiments described above clearly show that, so far as preparatory tillage with the *desi* implements is concerned, the present methods followed by the Marhatwada cultivator need no improvement. This should not be surprizing in view of the fact that the local practices of to-day are an outcome of the trial and error methods extending over centuries. The neglect of the land between the previous harvest and *Ugadi* (the Agricultural New Year) as brought about by the present system of land tenure, so far as the preparatory tillage is concerned, does not seem to have any untoward effect on the following cotton crop.

Weeding forms a very important interseasonal operation of cotton cultivator without which the yields suffer very considerably. The frequency of useful weedings, however, would naturally depend upon the distribution of the rainfall, which in its turn controls the density and growth of the weeds. It is the competition effect of the weeds that has to be guarded against. This weeding operation is usually done by cultivator by such implements as serve a dual purpose, viz. that of weed removal and soil mulch. The above experiment has shown that in such matters, the common *khurpi* is more efficient than either the blade hoe (*kolpa*) or the ' Indore ridger '. This is probably due to the fact that the effect of ' blade hoe ' is usually limited to the mulching and weeding of a 6—8 in. soil strip only, that lies between the crop rows 18 in. apart. Further, its deeper penetration in the soil has probably a disturbing effect on the root system. In case of ridging, the same effects are present in a greater degree. *Khurpi*, on the other hand, leaves no patch of the soil unmulched or unweeded and also gives the least disturbance to the roots. Further the blade hoe (*kolpa*) and ridger worked with bullocks offer possibilities of injury to the crop by the treading of the animals.

Previous work regarding preparatory tillage conducted by the different Provincial Departments of Agriculture is mostly confined to the efficiency of ' inversion ' ploughs. An exhaustive review of this by Allan [1935] shows that in the black cotton soil tracts use of inversion plough has no particular advantage in improving the yields of crops over a country plough and that their utility was not marked anywhere except at places where weed control was a problem. Ramanatha Iyer *et al.* [1940] found that, in Madras, the differences in yield due to preparatory tillage treatments of ploughing and *bakharing* (*Guntaka*) were of insignificant order. The results of the present tillage experiments, although not strictly comparable with the ones where other types of implements are used, show that the conclusions of Russel and Keen [1938] that " Cultivations in excess of those needed to produce a seed bed and to keep down the worst of weeds did not confer any further benefit ..... " are upheld. These conclusions apply more particularly to soils that are virtually exhausted through continuous cultivation without adequate manuring.

Summary

Cultivation experiments with Gaorani 6 cotton conducted at the Cotton Research Station, Nanded, during the period 1941-45 showed that :

1. Variations in frequencies and timings of *bakharings* and ploughings in preparatory tillage for cotton grown after *kharif* or *rabi jowar* or after groundnut did not improve yield of Gaorani 6.

2. A weeded crop gave a significantly higher yield than the unweeded one. One weeding should be normally enough since additional weeding did not offer any extra benefit except in years of abnormally late rains.
3. *Khurpi* is the most suitable implement for intercultivation operations in Marhatwada.

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UTILIZATION OF TOMATOES FOR JUICE AND SEED EXTRACTION

By Mohd. Ishaq, B.Sc.(Agri.), Biochemist, Fruit Products Research Laboratory, Quetta, and I. D. Chughtai, B.Sc.(Hons.), M.Sc.(Tech.), Research Assistant

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TOMATO seed, a waste product in juice manufacturing factories, is utilized for extraction of seed oil in Italy [Sanborn, 1945] which is chiefly used in soap making. Waste material from manufactured tomato products is also used as cattle feed in America and Italy [Wiegand, 1944 : Sanborn, 1945], owing to its high nutritive value particularly protein content. No mention appears to have been made in the literature particularly in India about the utilization of tomatoes both for purposes of juice and seed extraction.

Baluchistan is eminently suited for growing tomatoes of excellent quality. The yield per acre is also very high and ranges from 20 to 25 tons. In the uplands, tomatoes are available from June to October and are especially prolific during July to September. In the lower lands of the Province, they are available during winter months. There are, at present, seven registered seed growers who produced about 47,710 lb. of vegetable seeds including 400 lb. of tomato seed in 1944. In 1945, about 2,000 lb. tomato seed was produced. A few small concerns are also engaged in the manufacture of various tomato products in Quetta and Gulistan.

The attention of the authors was drawn to the enormous wastage of juice occurring during seed extraction process and of the seed when juice making is the primary object. This wastage is bound to be further increased as the production of seed or juice increases. An effort was, therefore, made to utilize whole tomatoes for extraction of juice as well as seed so as to avoid wastage of the either product. In the following pages, treatment of tomatoes prior to juice extraction, extraction of juice and seed, preservation of juice, cost of production of juice and seed, etc., are discussed. A method of extraction of juice and seed is also described.

A problem of great economic importance both from the view point of vegetable seed growers and tomato juice manufacturers has been solved. It is to the mutual advantage of the seed growers and juice manufacturers to cooperate among themselves to avoid wastage of juice or seed. On the basis of tomato seed produced in 1945 by the registered seed growers of Quetta, not less than 133,400 lb. juice (about 1627 maunds) sufficient to produce about 74,000 cans of A2½ size was allowed to go to waste. Similarly, a huge amount of tomato seed is wasted by juice manufacturing concerns situated in seed raising parts of India, e.g. Baluchistan, Kashmir, etc. The wastage of either product can be avoided if the recommendations made in this article are followed. Their production costs would also considerably decrease and thus the producers as well as the consumers will be immensely benefited.

Methods

The method of juice manufacture as described by Lal Singh and Girdharilal [1944], was found to be best suited for the simple type of equipment available in these laboratories and was adopted with slight modifications. The usual fermentation method of tomato seed extraction was employed.

Raw material

Tomatoes of a variety locally known as Large Red, grown at the Fruit Experiment Station, were used. The fruit was medium large to large in size (weighing about six fruits to a lb.) and having a smooth surface and roundish shape. The fruit was allowed to remain on the bushes till it was fully mature and had developed a deep red colour. Individual fruits were then picked in to slat bottom wooden trays and brought to the laboratory.

Experimental

Experiments on extraction of juice and seed from whole tomatoes were conducted for two seasons, viz. 1943 and 1944. In 1943, fully ripe tomatoes were sorted, washed, trimmed and were mashed

into pulp by hand. A certain amount of juice expressed during the mashing process contained a fairly large percentage of the seed. This juice was separated by decantation and passed through monel metal sieve of 1 mm. mesh. The seed collected on top of the sieve was allowed to remain with a little quantity of juice in three different types of containers, viz. aluminium, earthenware and wooden for about two days during which period the mass fermented and seed settled down. The supernatant liquid was then poured off, seed washed with water and dried in shade. The remaining juice along with pulp was heated, for about five minutes, in a steam jacketed pan and juice extracted by working the pulp over monel metal seive of 1 mm. mesh. The juice was then immediately brought to a boil, sodium chloride added at the rate of 1 per cent, filled and processed [Lal Singh and Girdharilal, 1944]. The time of processing was increased to suit local conditions [Siddappa, 1942]. The experimental data collected are given in Tables I and II.

TABLE I

Tomato seed extraction (1943)

Expt. No.	Date	Variety	Weight of tomatoes taken in lb.	Weight of rejected tomatoes (being over-ripe) in lb.	Container used for seed extraction	Weight of seeds obtained	Colour of the seeds	Yeild per maund of tomatoes	Remarks
1	2	3	4	5	6	7	8	9	10
1	2-9-43	Local	200	10	Earthenware	(473 gm.) 16·70 oz.	Medium dull straw	6·85 oz.	The pulp left after seed extraction along with the juice extracted during the process was used for making tomato juice.
2	4-9-43	,,	165	10	Wooden	(388 gm.) 13·69 oz.	Light dull straw	6·80 ,,	Do.
3	7-9-43	,,	197	6	Aluminium	(470 gm.) 16·61 oz.	Deep dull straw	6·90 ,,	Do.

TABLE II

Tomato juice from whole tomatoes and from pulp after seed extraction (1943)

Expt. No.	Date	Variety	Weight taken in lb.	Weight rejected (over-ripe) in lb.	Process	Juice extracted during seed extraction in lb.	Juice from pulp left after seed extraction in lb.	Total Juice extracted in lb.	No. of 24 oz. bottles prepared	No. of bottles broken during processing	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
1	31-8-43	Local	200	8	Used whole tomatoes	..	..	119	75	3	....
2	2-9-43	,,	200	10	Used pulp left after seed extraction	24	90	114	69	4	About 5 lb. of juice was allowed to remain with the seeds to facilitate fermentation and settling process.
3	4-9-43	,,	165	10	Do.	19	78	97	57	3	Do.
4	7-9-43	,,	197	6	Do.	28	87	115	68	3	Do.

The above method was considered to be rather uneconomical as a fairly large percentage of seed remained in the pulp and could not be separated by the decantation of the juice. In 1944, on the basis of small scale experiments, the following procedure was adopted for extraction of juice and seed rom whole tomatoes.

After preliminary treatments of sorting, washing and trimming, the tomatoes were cut into halves, the locules containing seed were separated and the skin halves kept aside. The pulp from locules was worked over monel metal sieve of 1 mm. mesh and the seed remaining on top with coarse pulp was allowed to ferment for 24-48 hours in wooden containers. This material was then gently rubbed with hands and seed separated by immersion in cold water. The skin halves were mashed, heated in a steam pan for about five minutes and juice extracted in the same manner as from locules. This was mixed with the juice obtained from locules, the entire lot quickly brought to a boil and finally packed as mentioned above. For comparing the quality and production costs of juice as well as of seed, whole tomatoes were utilized for preparation of juice and seed separately. The juice was packed precisely in the same manner as described by Lal Singh and Girdharilal [1944], while for extraction of seed the whole tomatoes were mashed with hands after crushing [Lal Singh and Girdharilal, 1940], left for 24-48 hours and then rubbed with hands and the seed separated by immersion in cold water. Germination percentage of seed samples was determined by putting 100 seeds of each lot in folds of muslin cloth (kept constantly wet by immersion of its ends in water) placed in a constant temperature incubator (temperature 28-30°C.) for about 10 days and counting the number of seeds which had germinated during this period. The germination tests were conducted by about the end of November, 1944. The entire experimental data are given in Tables III to V.

Discussion of results

A perusal of the experimental data presented in Tables I and II would reveal that :

1. Out of three containers used for tomato seed extraction wooden containers gave seed of a light dull straw colour which was better in general outward appearance than that obtained either from earthen ware or aluminium vessels.

2. When tomatoes were used for juice extraction alone, 59·5 lb. of juice was obtained from 100 lb. of fruit ; and when both juice and seed were extracted, the yields of juice and seed per 100 lb. of fruit were 57 lb. and 8·4 oz. respectively. The decrease in the yield of juice was more than offset by the income realized from the sale of seed. Cost of production of juice worked out on the basis of a typical experiment in 1943 was as follows :

(a) *Juice from whole tomatoes (experiment 1 of Table II)*	
1. Cost of 200 lb. tomatoes at Rs. 8 per md. of 82 lb.	Rs. 19-8-2
2. Coal 4 md. at Re. 1 per maund	4-0-0
3. Salt 1·2 lb.	0-1-4
4. Labour 3 men at Re. 1 per man per day	3-0-0
5. Miscellaneous charges, e.g. cloth, preservative, etc.	0-9-0
6. Cost of 75 bottles of 24 oz. capacity at Rs. 4-14 per dozen	30-7-6
7. Cost of 75 crown corks at 3 pies each	1-2-9
Total	58-12-9
Net number of bottles prepared (after deducting breakage) 72	
Cost per bottle of 24 oz. capacity (exclusive of depreciation and supervision charges and cost of labelling which will amount to at one anna per bottle approximately)	0-13-1
(b) *Juice from pulp left after seed extraction (experiment 2 of Table II)*	
1. Cost of 200 lb. of tomatoes at Rs. 8 per maund of 82 lb.	Rs. 19-8-2
2. Coal 4 md. at Re. 1 per md.	4-0-0
3. Salt 1·1 lb.	0-1-3
4. Labour five men at Re. 1 per day	5-0-0
5. Miscellaneous charges, e.g. cloth, preservative, etc.	0-9-0
6. Cost of 69 bottles at Rs. 4-15 per dozen	28-0-6
7. Cost of 69 crown corks at pies 3 each	1-1-3
Total	58-4-2
Income from the sale of 16·7 oz. tomato seed at Rs. 20 per lb. (the actual retail price fixed by the Government ranged from Rs. 12-8 to 30 per lb.)	20-14-0
Net cost on juice	37-6-2
Net number of bottles prepared 65	
Net cost per bottle of 24 oz. capacity (exclusive of depreciation, supervision and labelling charges)	0-9-2

It is evident from the above that the cost of fruit is out-balanced by the income from sale of seed and in consequence of this the cost of production of juice is reduced by about 30 per cent.

Data of detailed experiments conducted during the 1944 season on the utilization of whole tomatoes for juice, seed and juice plus seed extraction given in Tables III to V, indicate the following :

(A) tomato juice from whole tomatoes (Table III)

TABLE III

Results of tomato juice extraction from whole tomatoes (1944)

Expt. No.	Date	Net weight of tomatoes taken in lb.	Weight of trimmings, skins, etc. in lb.	Percentage of loss due to trimming	Weight of juice in lb.	Percentage recovery of juice	Weight of water added in lb.	Percentage of water added in the juice in lb.	No. of cans prepared (A 2½)	Remarks
1	2	3	4	5	6	7	8	9	10	11
1	18th July	90·5	27·5	30·39	63	69·61	10·	15·87	41·	Rather abnormal rejecton
2	21st ,,	332	74	22·29	258	77·71	64	24·81	179	Good quality tomatoes—good yield of juice
3	24th ,,	162·5	42·5	26·15	120	73·85	30	25·0	81	Good quality tomatoes—good yield of juice
4	25th ,,	141·5	41·5	29·33	100	70·67	25	25·0	71	Rather abnormal rejection and low yield of juice
5	4th Sept.	92	36	39·13	56	60·87	19	33·93	43	Abnormal rejection—yield of juice rather low
6	11th ,,	396	101	25·50	295	74·5	30	10·17	173	Good quality raw material—good yield of juice
7	25th ,,	276	64	23·20	212	76·8	*Nil*	×	111	Good quality raw material—good yield of juice but of rather thin consistency
8	27th ,,	230	52	22·61	178	77·39	*Nil*	×	96	Good quality raw material—good yield of juice but of rather thin consistency
9	29th ,,	256	58	22·66	198	77·34	*Nil*	×	110	Good quality raw material—good yield of juice but of rather thin consistency
10	30th ,,	335	73	21·79	262	78·21	*Nil*	×	141	Good quality raw material—good yield of juice but of rather thin consistency
11	4th October	437	120	27·46	317	72·54	*Nil*	×	174	Good quality raw material—good yield of juice but of rather thin consistency
From 100 lb. tomatoes		2748·5	689·5 25·09	..	2059 74·91	..	..	..	1220 44	

1. One thousand two hundred and twenty cans (A 2½ plain) of juice were obtained from 2748·5 lb. tomatoes or 44 cans from 100 lb. fruit.

2. Juice of thicker consistency was obtained in the early and mid season than that from the late season's crop.

3. The wastage percentage varied from 21·79 to 39·13 and the yield of juice from 60·87 to 78·21 : the average figures being 25·09 and 74·91, respectively. This is a better yield than that reported by Lal Singh and Girdharilal [1944] and is mainly due to the high quality of raw material.

4. The juice was of a rich red colour and had a nice flavour and taste and kept very well during about 1½ year's storage.

5 Approximate cost of production of an A $2\frac{1}{2}$ can of juice was as follows :

(1) Cost of 2748·5 lb. tomatoes at As. 2 per lb.	Rs. 343-9-0
(2) Salt 20·6 lb. at Rs. 6 per maund	1-8-0
(3) Coal 1 md. for 50 cans at Re. 1 per md.	24-8-0
(4) Labour 1 man for 30 cans at Re. 1 per day	40-10-0
(5) Cost of 1220 cans at 36·98 pies per can inclusive of reforming charges	235-0-0
(6) Miscellaneous charges, e.g., electricity, labels, supervision, depreciation, allowance for spoilage, etc. at anna 1 pies 6 per can	114-6-0
Total cost on 1220 cans	759-9-0
Cost per can (A $2\frac{1}{2}$ plain)	0-10-0

(*B*) *Tomato seed from whole tomatoes* (*Table IV*)

TABLE IV

Results of tomato seed extraction from whole tomatoes (*1944*)

Expt. No.	Lot no. of seed	Date	Weight of tomatoes taken in lb.	Weight of seed obtained in gm.	Percentage recovery of seed	Germination percentage of seed	Remarks.
1	2	3	4	5	6	7	
12	3	21st July	150	692	1·02	93	Light dull straw, good appearance, good recovery
13	6	26th ,,	145	610	0·93	95	Light dull straw, attractive appearance, good recovery
14	7	29th ,,	134	542	0·89	93	Light dull straw, attractive colour, good outturn
15	8	31st ,,	210	744	0·78	80	Light dull straw, attractive colour, good yield
16	9	12th September	58	140	0·53	96	Medium dull straw, good appearance, fairly good recovery
17	$\frac{10}{11}$	18th ,,	152	456	0·66	84-75	Medium dull straw, good colour, fairly good recovery
18	12	25th ,,	30	57	0·42	94	Medium dull straw, good colour, fairly good recovery
19	$\frac{13}{14}$	10th October	120	79	0·15	60	Dull straw colour, low recovery, low germination percentage. Poor sample

From 999 3320 or 7·3 lb.
100 lb. 332·3 or 0·73 lb.

1. Nine hundred and ninety-nine lb. tomatoes were required for 7·3 lb. of seed, i.e. 100 lb. for 0·73 lb.
2. Percentage of seed recovery on fresh tomatoes varied from 0·15 to 1·02, the average figure being 0·67.
3. A higher yield of seed was obtained in the early season which gradually decreased as the season advanced. There was a marked decrease in the yield of seed obtained on the 10th October which considerably lowered the average figure. A detailed investigation in this connection is in hand.
4. The seed was of a high quality both in regard to its general appearance and germination power which varied from 60 to 96, the average being 85·6.
5. A seed of rather poor quality was obtained in the late season and its germination power also seemed to be impaired as the season advanced.
6. Approximate cost of production per lb. of seed was as follows :

(1). Cost of 999 lb. tomatoes at As 2 per lb.	Rs. 124-14-0
(2) Labour charges—two men for 100 lb. fruit at Re. 1 per head per day	20-0-0
Total cost of 7·3 lb. seed	144-14-0
Cost per lb.	19-13-6

(C) Tomato juice and seed (Table V)

TABLE V

Results of tomato juice and seed extraction from whole tomatoes (1944 season)

Expt. No.	Lot No. of seed	Date	Net weight of tomatoes taken in lb.	Weight of trimmings and skins etc. in lb.	Percentage of loss due to trimming	Weight of juice in lb.	Percentage recovery of juice	No. of cans prepared (A 2½)	Quantity of seed in gm.	Percentage of fresh tomatoes	Germination percentage of seed	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13
20	1	18th July	143	49	34·27	94	65·73	53	617 ..	0·95	91	Good yield of juice and seed. High germination percentage.
21	2	21st ,,	126	38	30·16	88	69·84	47	630	1·10	96	Good yield of juice and seed. High germination percentage.
22	4	24th ,,	78·5	30·5	38·85	48	61·15	27	300	0·84	94	Good yield of juice and seed. High germination percentage.
23	5	25th ,,	106·5	33·5	31·46	73	68·54	39	497	1·03	100	Good yield of juice and seed. High germination percentage.
From 100 lb.			454	151·0 33·26		303 66·74	166 37	2044 450·2	or 4·5 lb. or 0·99 lb.			

1. One hundred and sixty-six cans (A 2½ plain) of juice and 4·5 lb. seed were obtained from 454 lb. fruit, i.e. 37 cans of juice and about 1 lb. seed from 100 lb. fruit respectively.

2. The wastage percentage varied from 30·16 to 38·85 and recovery of juice from 61·15 to 69·84 ; the average figure being 33·26 and 66·74, respectively. The yield of juice is thus slightly decreased when seed extraction is resorted to.

3. The recovery of seed was 0·84 to 1·10 per cent of fresh fruit, the average being 0·99. This is a very high figure when compared to the results of 1943 season where, approximately, 0·52 lb. seed was obtained from 100 lb. tomatoes. This may be attributed to several causes, e.g. the quality of raw material, seasonal variations, etc., but the improved method adopted for seed extraction in 1944 season seems to be chiefly responsible for increased recovery of seed.

4. The seeds had an attractive outward appearance ; their germination power ranged from 91 to 100 per cent, the average being 95·25.

5. The juice had a rich red colour, nice taste and kept very well in about 1½ year's storage. It had a marked tendency to separate into liquid and pulpy portions. This defect is however not very serious when the juice is packed in cans.

6. Approximate cost of production of an A 2½ can of juice was as under :

(1) Cost of 454 lb. tomatoes at As. 2 per lb.	Rs. 56-12-0
(2) Salt 3 lb. at Rs. 6 per md.	0-3-0
(3) Coal 1 md. for 50 cans at Re. 1 per md.	3-5-0
(4) Labour 1 man for 20 cans at Re. 1 per day	8-5-0
(5) Cost of 166 cans at 36·98 pies per can inclusive of reforming charges	32-0-0
(6) Miscellaneous charges, e.g. electricity, labels, depreciation, supervision, and allowance for spoilage, etc. at anna 1 pies 6 per tin	15-9-0
Total cost on 166 cans	116-2-0
Cost per tin	11-2-0
Deduct from this the cost of 4·5 lb. seed at Rs. 14 per lb. (Rs. 15 per lb. being the approved wholesale price for first class quality seed—the retail price being Rs. 30 per lb. minus Re. 1 per lb. on account of proportionate labour charges on seed extraction), i.e.	63-0-0
Net cost on 166 cans	53-2-0
Cost per can	0-5-0

The production cost is thus reduced by 50 per cent, when only juice is manufactured the cost being 10 annas per can.

General recommendations

During all stages of handling tomatoes for juice and seed extraction, contact with metals like iron, copper, zinc, lead, etc. should be avoided. For juice extraction, stainless steel, aluminium, nickle, glass lined equipment, nickle-copper alloys like monel metal can be safely used. For seed extraction, wooden containers or earthen ware can be employed with advantage. As a result of the investigation reported above, the following method for extraction of tomato juice and seed from whole tomatoes on a semi-commercial scale is recommended.

Step I. Select fully ripe red coloured tomatoes reasonably free from cracks. Wash thoroughly by soaking them in water in cemented tanks and then by holding under strong sprays of water. Remove carefully green and blemished portions, if any.

Step II. Cut the fruit into halves, remove the locules containing seeds and keep aside the skin halves. Work the pulp (from locules) over 1 mm. mesh monel metal or stainless steel sieve and collect the juice and seed (along with the coarse pulp) thus separated and proceed as follows :

Seed. Keep the seed in wooden containers or earthenware for 24-48 hours for fermentation, then rub it gently with hands and separate the seed by immersion in cold water in suitable containers. The coarse material will float on top leaving the clean seed at the bottom of the container. Dry the seed in shade and when perfectly dry, pack in suitable cardboard or other containers.

Juice. Heat the skin halves for three to five minutes in an open aluminium vessel on direct fire or in a steam jacketed kettle. Strain through a sieve of 1 mm. mesh made of monel metal or stainless steel [Lal Singh and Girdharilal, 1940] or pass the mass through a pulping or straining machine [Lal Singh, Giridhari Lal and Mohd Ishaq, 1943]. Mix the juice thus obtained with that extracted from the locules. Bring the entire lot quickly to a boil, regulate total solids content [Cruess, 1938] and proceed as described by Lal Singh and Girdhari Lal [1944, (Step III)], taking care that processing time is regulated according to the height of the place where work is conducted.

For work on commercial scale, use of a crusher consisting of two revolving adjustable grooved wooden rollers placed horizontally for crushing tomatoes and of a pulping or straining machine for removing seed and skin are believed to be highly beneficial. It is, however, to be seen whether the germination power of seed is affected by thorough scrubbing of the material with the revolving brushes of the pulping machine. Due to the non-availability of these machines, this aspect of the problem could not be studied.

Summary

A critical study has been made on the following aspects of utilization of tomatoes for juice, seed and juice plus seed extraction, viz. (a) preliminary treatments of sorting, washing and trimming, (b) extraction of juice, (c) extraction of seed, (d) suitability of various containers for seed extraction, (e) cost of production of juice and seed, and (f) germination power of seed. A problem of great economic importance both from the view point of vegetable seed growers and tomato juice manufacturers has been solved. Results are briefly indicated below :

Out of the three types of containers used, viz. aluminium, wooden and earthenware for seed extraction, wooden containers yielded the best product.

When tomatoes were used for juice extraction alone, 44 cans (A2½ plain) were obtained from 100 lb. fruit and the cost of production per can was annas 10.

0·73 lb. of seed was obtained from 100 lb. tomatoes when exclusively utilized for seed extraction and the cost of production of seed was Rs. 19-13-6 per lb.

When tomatoes were utilized for juice as well as for seed extraction, 37 cans (A2½ plain) of juice and about 1 lb. of seed were obtained from 100 lb. fruit. The additional cost on seed extraction was Re. 1 per lb. and the cost of production of an A2½ size can of juice (after making an allowance for the value of the seed extracted) came to annas 5 only.

The quality of juice and seed obtained under various treatments was very good and the juice kept very well in about 1½ years' storage.

Juice and seed of rather inferior quality were obtained from the late season's crop than from the tomatoes collected in the early or mid season. The percentage recovery of the seed seemed to decrease as the season advanced and its quality and germination power also seemed to be impaired.

A method for extraction of juice and seed from whole tomatoes has been described.

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SOME FUNGI FROM ASSAM, II

By S. Chowdhury, Plant Pathological Laboratory, Sylhet, Assam

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(With two text-figures)

THIS is the author's second contribution to the study of Assam fungi. The collections were made during 1943 and 1944. In the identification of a few fungi help was received from Dr B. B. Mundkur and Mr Azmatulla Khan of the Imperial Agricultural Research Institute, New Delhi, and from Mr E. W. Mason of the Imperial Mycological Institute, England; the author's thanks are due to them.

I. PHYCOMYCETES

Oomycetes

Peronospora Gaumannii Mundkur (*Sci. Monogr. Counc. Agri. Res., India*. **12** : 8, 1938).

On leaves of *Argemone mexicana* L. Karimganj, Sylhet. S. Chowdhury. 7-2-44. Herb. Plant Path. Lab. Sylhet. No. 46.

P. parasitica (Pers.) de Bary (*Sacc.* VII : 249 ; *Ann. Myc.* **5** : 512, 1907).

On leaves of *Raphanus sativus* L. Habiganj. S. Chowdhury. 14-2-44. Herb. Plant Path. Lab. Sylhet. No. 47.

P. variabilis Gaumann (*Sacc.* XXIV : 39 ; *Beitrage zur Kryptogamen flora der Schweiz.* **5** : 226,1923).

On leaves of *Chenopodium album* L. Rainagar, Sylhet. S. Chowdhury. 12-2-44. Herb. Plant Path. Lab. Sylhet. No. 48.

Pseudoperonospora cubensis (Berk. & Curt.) Rost. (*Sacc.* XVI : 520 ; *Ann. Myc.* **10** : 244, 1912 ; Butler-*Fungi and Disease in Plants*. 311, 1918).

On leaves of *Cucumis melo* L. Sylhet. S. Chowdhury. 21-2-44. Herb. Plant Path. Lab. Sylhet. No. 49.

Pythium aphanidermatum (Edson) Fitzpatrick (*Mem. Dep. Agri. India Bot. Ser.* **15** : 79-84, 1928 ; *Sacc.* XXIV : 1332).

On the stems of *Amaranthus gangeticus* L. and on the fruits of *Lagenaria vulgaris* Seringe, Sylhet. S. Chowdhury. 7-6-44 and 12-12-44. Herb. Plant Path. Lab. Sylhet. Nos. 50, 51.

Zygomycetes

Choanephora infundibulifera (Currey) Cunningham (*Trans. Linn. Soc.* II *Ser. Bot.* 1 : 417, 1879 ; *Sacc.* IX : 339 ; *Ann. Royal Bot. Gard. Cal.* **6** : 163, 1895).

On flowers of *Hibiscus rosa-sinensis* L. Sylhet. S. Chowdhury. 12-1-44. Herb. Plant Path. Lab. Sylhet. No. 52.

Cunninghamella elegans Lender (Sacc. XXI : 828).

Isolated from different types of soil collected from different localities of Sylhet.

Mucor racemosus Fresenius (*Sacc.* VII : 192 ; *J. Indian Inst. Sci.* **11A**. 12 : 141-60, 1928).

Isolated from arable soils of Maulvibazar and Karimganj.

Rhizopus nigricans Ehrenberg (*Sacc.* VII : 212 ; *J. Indian Inst. Sci.* **11A**. 12, 41-60, 1928).

Isolated from *pan* (*Piper betle L.*) *boroj* soils of Shaistaganj and Karimganj.

II. ASCOMYCETES

Hemiascomycetes

Protomycetes macrosporus Unger (*Sacc.* VII : 319 ; *Ann. Myc.* **9** : 372, 1911).

In living green parts of *Coriandrum sativum* L. Lakshmibasa. S. Chowdhury. 27-1-44. Herb. Plant Path. Lab. Sylhet. No. 53.

Discomycetes

Sclerotinia sclerotiorum (Lib.) de Bary [*Mem. Dept. Agri. India. Bot.* Ser. **13**, 2, 39-46, 1924 : *Sacc.* XXII : 644 as *S. sclerotiorum* (Lib.) Sacc. and Trott.].

On *Brassica campestris* L. var *sarson* Prain ; Purangaon. S. Chowdhury. 10-3-44. Herb. Plant Path. Lab. Sylhet. No. 54.

Pyrenomycetes

Asterina camelliae Syd. & Butler (*Ann. Myc.* **9** : 389, 1911 : *Sacc.* XXIV : 474 *Abhandl. k. k. Zool. Bot. Gesellsch. Wien.* **7**, 3, 83, 1913).

On leaves of *Thea sinensis* L. Baraura, Sylhet. S. Chowdhury. 7-11-44. Herb. Plant Path. Lab. Sylhet. No. 55.

Asterinella stuhlmanni (P. Henn.) Theiss (*Broteria Ser. Bot.* **10**, 120, 1912 ; *Sacc.* XVII : 881 ; *Ann. Myc.* 9 : 392, 1911 as *Asterina stuhlmanni* P. Henn.).

On the leaves of *Ananas comosus* (L.) Merr. Debpur, Sylhet. S. Chowdhury. 10-12-44. Herb. Plant Path. Lab. Sylhet. No. 56.

Balladyna butleri Syd. (*Ann. Myc.* **9** : 388, 1911 ; *Sacc.* XXIV : 373).

On the culms of *Bambusa* sp. Lahkipur, Cachar. S. Chowdhury. 8-8-44. Herb. Plant Path. Lab. Sylhet. No. 57.

Capnodium citri Berk. & Desm. (*Indian J. agric. Sci.* **6** : 97, 1936 ; *Sacc.* I : 78).

On leaves and fruits of *Citrus* sp. Sylhet, Haflong. S. Chowdhury. 10-2-44. Herb. Plant Path. Lab. Sylhet. Nos. 58, 59.

C. eugeniarum Cke. (*Grev.* **8** : 96, 1880 ; *Sacc.* I : 78).

On leaves of *Eugenia jambos* L. Shillong. S. Chowdhury. 12-9-44. Herb. Plant Path. Lab. Sylhet. No. 60.

C. ramosus Cke. (*Grev.* **21** : 76, 1893 ; *Sacc.* XI : 271).

On leaves of *Mangifera indica* L. Illaspur. S. Chowdhury. 21-12-44. Herb. Plant Path. Lab. Sylhet. No. 61.

C. theae Boed (Boedijn : *Bull. Jard. Bot. Buitenzorg Ser.* III, 11 : 223, 1931).

On leaves of *Thea sinensis* L. Sridharpur. S. Chowdhury. 19-10-44. Herb. Plant Path. Lab. Sylhet. No. 62.

Ceratostomella paradoxa (de Seynes) Dade [*Trans. Brit. Mycol. Soc.* **13** : 191, 1928 ; *Sacc.* XXII 1341 as *Thielaviopsis paradoxa* (de Seynes) v Hoehn ; *Agri. Res. Inst. Pusa Bull.* **127**, 1922].

On stems of *Areca catechu* L. and on the leaves and fruits of *Ananas comosus* (L.) Merr. Sylhet. S. Chowdhury. 12-7-44. Herb. Plant Path. Lab. Sylhet and Herb. Crypt. Ind. Orient. New Delhi. Nos. 63, 64.

Dothidea azmati Chowdhury n. sp.

Spots on the leaves distinct, hypophyllous ; stroma erumpent, usually pulvinate, sub-orbicular, single or gregarious, smooth, black, partly sunk in the tissue of the leaf. Perithecia sunk in the stroma ; asci oblong 58-74×9-12 μ, soon disappearing. Spores elliptical to fusiform, sub-biseriate, uniseptate, straight or very slightly curved, slightly constricted at the septa. 17-24×4-7 μ, brown.

On the living leaves of *Setaria palmifolia* Stapf. causing distinct leaf spots on both surfaces of the leaf ; Haflong. 30 December, 1943. Collected by S. Chowdhury.

Type specimen deposited in the Herb. Crypt. Ind. Orient. New Delhi. No. 65.

Maculis in foliis, destinctis. hypophyllis, stromatibus erumentibus. generatim pulvinatibus, sub-orbicularibus, unicis vel gregariis, atris, nigris, parte, in folii histu mergatum. Peritheciis in stromum mergatis ; ascis oblongis, 58-74×9-12μ, mox disapparentes. Sporidiis ellipticis vel fusiformis, sub districhis, uniseptatis, strictis vel subcurvatis, ad septa paulo constrictis, 17-24 ×4-7μ, brunneis.

In foliis viris *Setariae palmifoliae* Stapf. Haflong, 30-12-43. S. Chowdhury. No. 65. Typus in Herb. Crypt. Ind. Orient. New Delhi.

FIG. 1. *Dothidea Azmati* Chowdhury N. Sp.
a. Portion of a leaf showing spots. *b*. Section through a perithecium. *c*. An ascus with ascospores. *d*. Ascospores.

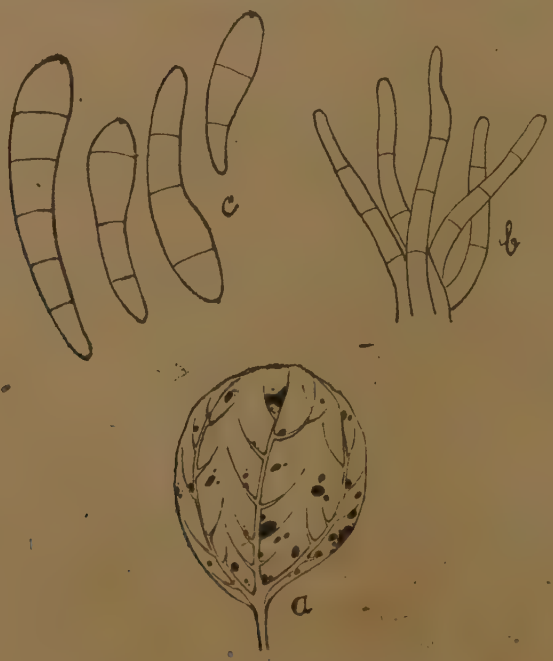

FIG. 2. *Cercospora Jujuabae* Chowdhury n. sp.
a Leaf showing spots. *b*. A tuft of conidiophores. *c*. Conidia.

Glomerella cingulata (Stonem) Spaulding & v Schrenk (*Sacc.* XVII : 573 and XVI : 452 : *Ann. appl. Biol.* **6** : 245, 1920).

On leaves of *Piper betle* L. Jaintapur. S. Chowdhury. 15-9-44. Herb. Plant Path. Lab. Sylhet. No. 66.

G. major Tunst. (*Trans. Brit. Mycol. Soc.* **19** : 331-36, 1935).

On woody branches of *Thea sinensis* L. Barkandi. S. Chowdhury. 17-7-44. Herb. Plant Path. Lab. Sylhet. No. 67.

Leptosphaeria agaves Syd. & Butler (*Ann. Myc.* **9** : 409, 1911 ; *Sacc.* XXIV : 979).

On fading leaves of *Agave sisalana* Perrine. Karimganj. S. Chowdhury. 7-7-44. Herb. Plant Path. Lab. Sylhet. No. 68.

L. sacchari Breda de Haan (*Sacc.* XI : 324 ; *Ann. Myc.* **9** : 409 : 1911 ; *Mem. Dept. Agric. India Bot. Ser.* 1, 3 : 1-53, 1906).

On leaves of *Saccharum officinarum* L. Kamalganj. S. Chowdhury. 9-10-44. Herb. Plant Path. Sylhet No. 69.

Meliola butleri Syd. (*Ann. Myc.* **9** : 389, 1911 ; *Sacc.* XXIV : 338 ; *J. Dept. Sci. Cal. Univ.* V, 1-17, 1922).

On leaves of *Citrus* sp. Jaintapur. S. Chowdhury. 2-1-44. Herb. Plant Path. Lab. Sylhet. No. 70.

M. mangiferae Earl (*Sacc.* XXII : 48 ; *Ann. Myc.* **9** : 382, 1911).

On leaves of *Mangifera indica* L. Karimganj. S. Chowdhury. 18-11-43. Herb. Plant Path. Lab. Sylhet. No. 71.)

Nectria cinnabarina (Tode) Fr. (*Ann. Myc.* **9** : 393, 1911 ; *Sacc.* II : 479 ; *Quart. J. Indian Tea Assocn.* **3**, 86-91, 1923 ; *Quart. J. Indian Tea Assocn.* **1** : 32-44, 1925).

On stems of *Thea sinensis* L. Barkandi, Sylhet. S. Chowdhury. 8-8-44. Herb. Plant Path. Lab. Sylhet. No. 72.

Phyllachora bambusae Syd. & Butler (*Ann. Myc.* **13** : 441, 1915 : *Sacc.* XXIV : 576).

On living leaves of *Bambusa* sp. Sylhet. S. Chowdhury. 27-12-44. Herb. Plant Path. Lab. Sylhet and Herb Crypt. Ind. Orient. New Delhi. No. 73.

P. cynodontis (Sacc.) Niessl (*Ann. Myc.* **9**: 399, 1911 ; *Ann. Myc.* **11** : 328, 1913 ; *Sacc.* II : 602).

On leaves of *Cynodon dactylon*, Sylhet. S. Chowdhury. 18-2-43. Herb. Crypt. Ind. Orient., New Delhi and Herb. Plant Path. Lab. Sylhet. No. 74.

P. dalbergiae Niessl (*Hedw.* **20** : 99, 1881 ; *Sacc.* II, 594 ; *Ann. Myc.* **9** : 397, 1911).

On leaves of *Dalbergia sissoo* Roxb. Satgaon. S. Chowdhury. 8-3-44. Herb. Crypt. Ind. Orient. New Delhi and Herb. Plant Path. Lab. Sylhet. No. 75.

P. fimbristylicola Speg. (*Ann. Myc.* **9** : 398, 1911 ; *Sacc.* XXII, 423).

On leaves of *Fimbristylis* sp. Habiganj. S. Chowdhury. 12-10-43. Herb. Plant Path. Lab. Sylhet. No. 76.

P. sorghi v Hoehn (*Sacc.* XXII : 426).

On leaves of *Sorghum vulgare* Pers. Katakhal. S. Chowdhury. 21-9-43. Herb. Plant Path. Lab. Sylhet. No. 77.

III. BASIDIOMYCETES

Ustilaginales

Sphacelotheca sorghi (Lk.) Clinton (*Sacc.* VII : 456 as *Ustilao sorghi* (Link) Pass., *Ann. Myc.* **4** : 425, 427, 1906 ; *Agri. J. India* **17** : 159-62 1922 ; *Mycologia* **22** : 125-58, 1930).

On the ovaries of *Sorghum halepense* (L.) Pers. (Syn. *Andropogon halepensis* Brot.) Sylhet. S. Chowdhury. 6-2-43. Herb. Crypt. Ind. Orient., New Delhi., and Herb. Plant Path. Lab. Sylhet. No. 78.

Uredinales

Hemileia vastatrix Berk. & Broome (*Sacc.* VII : 585 ; *Zeitsch. fur Pflanzenkr.* **15** : 47, 1905 ; *Popular Sci. Rev.* **15** : 161-68, 1875 ; *Planters' Chron.* **19** : 698, 1924 ; *Grev.* **4** : 116, 1875 ; *Kew Bull.* 1906 : 35-42, 1906).

On leaves of *Coffea arabica* L. Dalaipara, Sylhet. S. Chowdhury. 2-8-44. Herb. Plant Path. Lab. Sylhet. No. 79.

Puccinia maydis Bereng (*Sacc.* VII : 659 as *P. sorghi* Schw. ; *Ann. Myc.* **4** : 434. 1906 : *J. Asiat. Soc. Bengal* **60** : 214, 1891 as *P. sorghi* Schw. Butler —*Fungi and Disease in Plants.* 193, 1918).

On leaves of *Zea mays* L. Upper Shillong. S. Chowdhury. 6-8-44. Herb. Plant Path. Lab. Sylhet. and Herb. Crypt. Ind. Orient. New Delhi. No. 80.

P. nakanishikii Diet (*Ann. Myc.* **4** : 435, 1906 ; *Sacc.* XXI : 691).

On leaves of *Cymbopogon khasianus* Stapf. ex Bor. Latu. Sylhet. S. Chowdhury. 12-12-43. Herb. Plant Path. Lab. Sylhet, and Herb. Crypt. Ind. Orient., New Delhi. No. 81.

P. thwaitesii Berk (*Ann. Mycol.* **4** : 431, 1906 ; *Sacc.* VII : 720).

On leaves of *Justicia gendarussa* L. Sylhet. S. Chowdhury. 8-8-44. Herb. Plant Path. Lab., Sylhet, and Herb. Crypt. Ind. Orient. New Delhi. No. 82.

Uromyces fabae (Pers) de Bary (*Sacc.* VII : 531 ; *Ann. Myc.* **4** : 428, 1906 ; *Ann. Myc.* **10** : 255, 1912).

On leaves, stems and pods of *Lens esculenta* Moench. Kasba, Sylhet. S. Chowdhury. 6-12-44. Herb. Plant Path. Lab. Sylhet. No. 83.

Hymenomycetes

Agaricus latipes Berk (Sacc. V : 1000).

On the ground, Dawki. S. Chowdhury. 18-8-44. Herb. Plant Path. Lab. Sylhet. No. 84.

Boletus areolatus Berk (*Sacc.* VI : 44).

In open pastures. Upper Shillong. S. Chowdhury. 28-8-44. Herb. Plant Path. Lab. Sylhet. No. 85.

B. flavipes Berk (*Sacc.* VI : 28).

On the ground Upper Shillong. S. Chowdhury. 28-8-44. Herb. Plant Path. Lab. Sylhet. No. 86.

B. scrobiculatus Berk. (Sacc. VI : 37).

On soil in open places, Moflong, Khasi Hills. S. Chowdhury. 29-8-44. Herb. Plant Path. Lab. Sylhet. No. 87.

Exobasidium vexans Massee (*Kew Bull.* 1898 : 105-12, 1898 ; *Sacc.* XVI : 198 ; Butler : *Fungi and Disease in Plants.* 422. 1918. *Indian Tea Assocn. Bull.* **3**, 1906 : *Agri Res. Inst. Pusa Bull.* **18**. 1910 : *Agri. J. India* **5** : 126-37. 1910 ; *Ann. Myc.* **10** : 274, 1912 ; *Quart. J. Indian Tea Assocn.* **1** : 35-43, 1922 ; *Quart. J. Indian Tea Assocn.* **1** : 20-4, 1927).

On leaves and twigs of *Thea sinensis* L. Sylhet. S. Chowdhury. 7-9-43. Herb. Plant Path. Lab. Sylhet. No. 88.

Polyporus anthelminticus Berk. (*Gard. Chron.* 753. 1866 ; *Sacc.* VI : 79 ; *Proc. Sci. Convention, Indian Assoc. Cult. Sci. for the year* 1920-21 : 30, 1923).

On dead root of *Bambusa sp.* Inathganj. Sylhet. S. Chowdhury. 2-8-45. Herb. Plant Path. Lab. Sylhet. No. 89.

P. friabilis Bose (*J. Indian Bot.* **2** : 300-1, 1921).

On the ground and on the living and dead *Bambusa* sp. Lakshmibasa. Sylhet. S. Chowdhury. 16-7-44. Herb. Plant Path. Lab. Sylhet. No. 90.

Poria diversispora Berk. & Broome (Sacc. VI : 324 ; *Bull. Charmichael Med. Coll.* **1** : 1, 1920).

Common usually on old *Bambusa* sp. Sylhet. S. Chowdhury. 10-2-44. Herb. Plant Path. Lab. Sylhet. No. 91.

P. hypobrunnea Petch. (*Ann. Royal Bot. Gardn. Peradeniya* **6** : 51, 1916 ; *Sacc.* XXIII : 419 ; *Quart. J. Indian Tea Assocn.* **1** : 38, 1925).

A common cause of die-back of the stems of *Thea sinensis* L. Binnakandi, Cachar. S. Chowdhury. 14-3-43. Herb. Plant Path. Lab. Sylhet. No. 92.

Stereum percome B. & Br. (*Sacc.* VI : 576 ; *Ann. Myc.* **34** : 38, 1936).
On living and dead *Bambusa* sp. Silchar, Cachar. S. Chowdhury. 17-3-43. Herb. Plant Path. Lab. Sylhet. No. 93.

S. petalodes Berk. (*Sacc.* VI : 557 ; *Ann. Myc.* **34** : 27, 1936).
On dead *Bambusa* sp. Karimganj, Sylhet. S. Chowdhury. 12-3-43. Herb. Plant Path. Lab. Sylhet. No. 94.

Trametes cubensis (Mont.) Sacc. (*Sacc.* IX : 198 ; *Ann. Myc.* **35** : 134, 1937).
On dead *Bambusa* sp. Matijuri, Hailakandi. S. Chowdhury. 8-3-44. Herb. Plant Path. Lab. Sylhet. No. 95.

T. mollis Fries (*Sacc.* VI : 354 ; *J. Dept. Sci. Calcutta Univ.* **11** : 11, 1934).
On branches of *Alnus* sp. Shillong. S. Chowdhury. 24-10-44. Herb. Plant Path. Lab. Sylhet. No. 96.

T. persooni Fries (*Sacc.* VI : 272 as *Polystictus persooni. Ann. Myc.* **35** : 133, 1937).
On living and dead *Bambusa* sp. Katakhal, Cachar. S. Chowdhury. 19-3-43. Herb. Plant Path. Lab. Sylhet. No. 97.

IV. FUNGI IMPERFECTI

Hyphomycetes

Acrothecium lunatum Wakker (*Sacc.* XIV : 1089 ; *Mem. Dept. Agri. India. Bot. Ser.* **11**, 3, 57-74, 1921 ; *Annotated Account of Fungi Received at the Imperial Bureau of Mycology.* List II : 2, 1928).
On leaves of *Andropogon sorghum* Brot. Sylhet. S. Chowdhury. 15-7-44. Herb. Plant Path. Lab. Sylhet. No. 98.

Cephalosporium sacchari Butler (*Mem. Dept. Agri. India. Bot. Ser.* **6**, 6 : 181, 1913 ; Butler : *Fungi and Disease in Plants* : 402 : 1918).
In culms of *Saccharum officinarum* L. Sylhet. S. Chowdhury. 17-11-44. Herb. Plant Path. Lab. Sylhet. No. 99.

Cercospora arachidiocola Hori (*Phytopath.* **23** : 627-640, 1933 ; Uppal *et al* : The Fungi of Bombay. 29, 1935).
On leaves, stems and petioles of *Arachis hypogaea* L. Haflong. S. Chowdhury. 6-8-43. Herb. Plant Path. Lab. Sylhet. No. 100.

C. dioscoreae Ell. & Mart. (*Sacc.* IV : 479 ; *Annales Crypt. Exot.* II : 265, 1929, 1930).
On leaves of *Dioscorea* sp. Satgaon. S. Chowdhury. 15-1-43. Herb. Plant Path. Lab. Sylhet. No. 101.

C. jujubae Chowdhury n. sp.
Mycelium hypophyllous, branched, septate, both internal and external. Conidiophores fasciculate, emerging through the stomata or rupturing the epidermis, fuscous, 48-152×4-7 μ, 1-4 septate, constricted at the septa, sometimes swollen at the base, with distinct geniculations and conidial scars. Conidia clavate, solitary, apical, straight or very slightly curved, light olive gray, 1-5 septate, 25-45×8-10 μ, bearing a distinct hilum at the base.
On the lower side of the leaves of *Zizyphus jujuba* Lam. Maulvibazar. 8-2.44. Collected by S. Chowdhury.
Type specimen deposited in the Herb. Crypt. Ind. Orient. New Delhi.
Mycelie hypophyllo, ramoso, septate, interne et externe ; conidiophoris fasciculatis, ex stomatibus emergentis vel epidermis erumpentis, fuscis, 48-152×4-7 μ, 1-4 septatis, ad septa constrictis ad bascim interdum, ampulliformism cum distinctis geniculatimibus et conidiolibus hilibus. Conidiis clavatis, solitariis, apicis, strictis vel subcurvatis, pallide olivaceis, 1-5 septatis, 25-45×8-10 μ, ad bsaim cum hilo distincto.
In foliis *Ziziphi jujubi* Lam. Maulvibazar. 8-2-44. (S. Chowdhury No. 102 Typus). Typus in Herb. Crypt. Ind. Orient., New Delhi.

C. longipes Butler [*Mem. Dept. Agri. India. Bot. Ser.* **1**, 3, 41, 1906 ; *Annales Crypt. Exot.* II, 267, 1929 (1930) ; Butler : *Fungi and Disease* in Plants. 405, 1918].
On leaves of *Saccharum officinarum* L. Sylhet. S. Chowdhury. 7-11-44. Herb. Plant Path. Lab. Sylhet. No. 103.

REVIEW

A Review of the Literature on Soil Insceticides. Edited by H. C. Gough (*Published by the Director, Imperial Institute of Entomology, London, p. 161, Price 10s.*).

THE application of an insecticide to the soil is much more complex than applying it to plant foliage, etc., because in the soil the insecticide is likely to disturb the equilibrium in soil micro-organisms or may react directly or indirectly with manures and fertilizers. There are numerous observations in literature of various countries on the efficacy of soil insecticides. Dr. Gough has rendered a great service to the entomologists by compiling all the information available in the brochure under review. His method of treatment of the subject is admirable. He has discussed all the important insecticides one by one and under each individual insect against which they have been applied they are arranged in a systematic manner. The important group of soil nematodes is omitted deliberately because this subject is recognized by the author to have a literature of its own. The control of Myriopods and Arachnide is, however, included.

When the brochure appeared it was thought that some conclusions would be drawn as to which insecticides are most efficacious against various important pests. However, the conclusions actually drawn from the review by Dr. Gough are rather meagre not because he has not examined the various research papers critically but because of the fact that contradictory results have been obtained by different authors for almost all the substances tested. This shows that no systematic attempt has yet been made to critically examine the effect of different insecticides by isolating their influence from the other factors which operate in the soil medium. This also emphasizes the complexity of the problem as stated above. Anyway Dr. Gough's work is likely to result in simplification of the problem by stimulating research work in an extensive and critical manner.—H. S. P.

PLANT QUARANTINE NOTIFICATIONS

Notification No. F. 15-1/45-A., dated the 27th December 1945, of the Government of India in the Department of Agriculture.

The notifications of the Government of India in the Department of Agriculture No. F. 15-1/45-A, dated the 25th September 1945 and the 12th November 1945 are hereby cancelled.

Notification No. F. 3-1/46-PP., dated the 17th August 1946, of the Government of India in the Department of Agriculture.

In exercise of the powers conferred by Sub-section (1) of Section 3 of the Destructive Insects and Pests Act, 1914 (II of 1914), the Central Government is pleased to direct that the following further amendment shall be made in the Order published with the notification of the Government of India in the late Department of Education, Health and Lands No. F. 320/35-A., dated the 20th July 1936, namely: —

In paragraph 8B of the said Order, after the word " Burma " the words " or the Kalat State " shall be inserted.

MGIPC—M—III-1-14—24-9-47— 600.

Instructions to Authors

Articles intended for the *Indian Journal of Agricultural Science* should be accompanied by short popular abstracts of about 300 words each.

In the case of botanical and zoological names the International Rules of Botanical Nomenclature and the International Rules of Zoological Nomenclature should be followed.

References to literature, arranged alphabetically according to author's names, should be placed at the end of the article, the various references to each author being arranged chronologically. Each reference should contain the name of the author (with initials), the year of publication, title of the article, the abbreviated title of the publication, volume and page. In the text, the reference should be indicated by the author's name, followed by the year of publication enclosed in brackets; when the author's name occurs in the text, the year of publication only need be given in brackets. If reference is made to several articles published by one author in a single year, these should be numbered in sequence and the number quoted after year both in the text and in the collected references.

If a paper has not been seen in original it is safe to state 'original not seen'.

Sources of information should be specifically acknowledged.

As the format of the journals has been standardized, the size adopted being crown quarto (about $7\frac{1}{8}$ in. $\times$ $9\frac{5}{8}$ in. cut), no text-figure, when printed, should exceed $4\frac{1}{2}$ in. $\times$ 5 in. Figures for plates should be so planned as to fill a crown quarto plate, the maximum space available for figures being $5\frac{3}{4}$ in. $\times$ 8 in. exclusive of that for letterpress printing.

Copies of detailed instructions can be had from the Secretary, Imperial Council of Agricultural Research, New Delhi.